MaNEP SWITZERLAND

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MaNEP

Materials with Novel Electronic Properties

National Centre of Competence in Research

FINAL REPORT

2001 – 2013

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Cover Image: *Illustration of the pseudogap phase of the high-T_c cuprates. The green hilly landscape represents the energy (vertical direction) as a function of momentum in the CuO_2 planes (planar dimensions). The Fermi-liquid condenses in the lowest energy states of this landscape, and forms lakes. The finite size and filling of these lakes is a manifestation of the Fermi-liquid character of the condensate. The periodicity of the energy-momentum landscape is indicated by the yellow markers on the hilltops. Each of those is surrounded by four lakes, which have become disconnected from each other by an energy barrier representative of the pseudogap. Illustration courtesy of Damien Stricker.*

NCCR: Final Report over the entire NCCR term – Cover Sheet

Title of the NCCR	Materials with Novel Electronic Properties (MaNEP)
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1. Executive summary

The proposal to establish a National Centre of Competence in Research (NCCR) focusing on Materials with Novel Electronic Properties (MaNEP) was motivated by the fact that major advances in technology are often made possible by breakthroughs in material science. The 20th century had been dominated by metals and semiconductors in a broad range of technologies. The vision for MaNEP was that electronic materials with novel properties would contribute to shaping the technological society of the 21st century. A large selection of materials was considered, including complex oxides, intermetallics, carbon nanotubes, fullerenes and organic materials.

The full proposal was submitted in 2000 and the NCCR MaNEP was launched upon approval by the SNSF on July 1, 2001, with Øystein Fischer as director and Jean-Marc Triscone as deputy director. Twenty-five senior scientists contributed to setting up the NCCR as a Network representing four universities, three federal institutes and three industries. By the end of phase III, the Network will count sixty-eight senior scientists and over fifteen industries. These numbers are a testimony to the structural impact the NCCR had in Switzerland.

Phase I was organised in five programmes covering seventeen individual projects distributed among the participating institutions. Three of the five programmes had an industrial partner, one programme being specifically dedicated to superconducting materials for applications. In addition to scientific excellence, phase I aimed at gathering and uniting the Swiss condensed matter physics community. Advertising the Network und publicising its competences and facilities was also the emphasis of communication, knowledge and technology transfer (KTT) and outreach.

The scientific programme was significantly reorganised at the start of **phase II**. Individual projects were replaced by three collaborative programmes focusing on i) the fundamental understanding of electronic materials with strong interactions; ii) the search for novel materials and their synthesis; and iii) applications of novel materials for advanced systems and devices. A dedicated effort on the search for novel materials was introduced, adding materials chemists to the Network. Half-way through phase II, deputy director Jean-Marc Triscone became dean of the Faculty of Science at the Home institution. Two new deputy directors were appointed to the vacant position, Dirk van der Marel and Christoph Renner. A communication and a KTT officers were appointed to cope with the steadily increasing activity. During phase II, MaNEP launched a range of initiatives for education (e.g. doctoral and exchange programmes), equal opportunities and advancement of women (e.g. internships) and public outreach (e.g. PhysiScope).

The scientific programme in **phase III** was reorganised into eight collaborative projects. Most significant changes were the addition of cold atoms and the termination of the projects dedicated to the discovery of new materials. The latter were integrated into the scientific programmes. Despite the planned 45% reduction in SNSF funding, MaNEP grew in terms of total budget and scientific scope during phase III. The Network leadership and excellence established during the first two phases led to a strong commitment of the Home institution, participating universities, institutions and scientists. Together, they contributed to increase the total budget by 37%.

MaNEP has been very productive with excellent contributions to science, becoming a renowned brand at the national and international level. Over 3’100 articles have been published. Annual citations reached nearly 9’000 in 2012, with a notable shift to higher impact journals. The average journal impact factor grew from 3 to 7, with MaNEP achieving an h-factor of 86. In parallel, MaNEP conducted a strong effort to transfer its technology to industrial applications. The number of collaborating industries has increased from two during phase I to reach a total of twenty-eight over the twelve years. MaNEP was very successful in attracting additional SNSF funding (3.7 MCHF) to support its KTT efforts via the *economic stimulus package* and *transfer projects (strong Swiss franc package).* MaNEP has also been very active on education, communication and equal opportunities, with dedicated personnel hired in the management to animate these themes. Many of the above outreach activities aimed at society and industry set-up during MaNEP are to continue after the formal end of the NCCR: **KTT** through the *Geneva Creativity Center* (created in 2010) and the planned *Laboratory for Advanced Technology*; **education** with the *PhysiScope* (created in 2007) and the planned *SciScope*; **communication** with the itinerant exhibition based on the sculpture *SUPRA100* by Etienne Krähenbühl and other planned activities. Using art as a mean of introducing the general public to science and more specifically to the great challenges and potential of novel electronic materials has proven especially successful.

The NCCR has been a fantastic instrument to unite and strengthen the condensed matter physics scene in Switzerland. Two MaNEP members have been appointed to leading positions at key institutions in Switzerland (PSI director and Empa director). The field of quantum electronic materials has seen fascinating new materials (e.g. graphene, pnictides), processes (e.g. atomic-scale material synthesis) and physical concepts (e.g. topological insulators) emerge during the past twelve years. The amounts allocated to the NCCR and their flexibility have enabled the Swiss community to respond in a very timely and effective manner to these new challenges. Gathering all Swiss scientists in the field at regular meetings, topical workshops, schools and conferences has stimulated collaborations and concerted approaches to a given problem with different and complementary tools. The NCCR has had an extremely positive impact, both in reshaping the Swiss landscape in quantum electronic materials, and restructuring physics, astronomy and mathematics at the Home institution. Here, the NCCR will have far reaching and lasting benefits in the area of MaNEP — budget nearly doubled — and beyond the core topic of MaNEP, with significant additional support by the Home institution for the entire Physics Section, for astronomy and for mathematics.

2. Structure of the NCCR – development and perspectives for the future

2.1 Starting point and development of the NCCR

At the time of the SNSF call for NCCR proposals in 1999, many of the Swiss physicists interested in correlated electron systems were collaborating and meeting on a regular basis. This community primarily came together through the topic of high-temperature superconductivity, still among the outstanding and most fascinating challenges in condensed matter physics today.

Research themes

During **phase I** (2001 – 2005) the NCCR *Materials with Novel Electronic Properties* (MaNEP) was organised in five programmes. Superconductivity and related oxide materials formed the backbone of most of these programmes, with one specifically dedicated to superconducting materials for industrial applications. Three out of the five programmes did include an industrial partner, demonstrating the strong commitment to explore applications for the novel electronic properties to be discovered by the basic research. IBM dropped out at the start of phase I due to intellectual property issues. The programmes were divided into a total of sixteen projects, with two more added during the course of phase I. A scientific advisory board consisting of five senior scientists representing each programme was established to assist the director in the scientific direction of the NCCR. Overall management was established at the Home institution, with a team to support administration, education, communication, reporting, meetings, and technology transfer. The latter was conducted in collaboration with UNITEC, the then newly created technology transfer office of the University of Geneva.

At the start of **phase II** (2005 – 2009) the structural organisation was modified, in particular to reinforce the search for new materials. The capacity to discover and synthesise novel materials had been recognised at an early stage of the NCCR as a crucial ingredient, not only for the success of MaNEP, but for the success of condensed matter research in general. To address the three main challenges in the field of novel electronic materials, namely develop a fundamental understanding of these materials, develop materials synthesis and search for new materials, and prepare for the applications of these materials, six projects were launched. Programmes dedicated to broadly search for novel materials with unusual electronic properties were introduced. To this end, the Network of participating institutions was enlarged to the University of Berne to include material chemists. During phase II, the Physics Institute at the University of Neuchâtel went through a major reshaping which led to the termination of all activities in the field of MaNEP. Some of them were transferred to the University of Fribourg, member of the Network. On the management side, the team was reinforced with a communication officer in charge of public events and press releases and a KTT officer. A scientific committee (formerly advisory board) was formed with the role of assisting the director in the scientific direction of the NCCR. An external advisory board of international scientific experts in the field of MaNEP was created on the basis of names proposed by project leaders. This committee was invited to report every two years on MaNEP activities. It had the important role to provide the director with an independent view on MaNEP activities and advise him on modifying projects or redefining the NCCR long terms goals.

A new structure was introduced for **phase III** (2009 – 2013) with eight projects based on well-defined scientific goals. The modified structure enabled MaNEP to respond to the strong demand from scientists outside the MaNEP Network to join the NCCR. In spite of the reduced SNSF contributions, the number of participating principal investigators in these new projects was nearly doubled. The status of associate member allowed accommodating such a large number of new participants. Associate members did benefit from the Network (Fig. 1) and could apply for special projects, but they did not receive any regular funding from MaNEP. Among the most notable changes to the scientific organisation were the addition of a specific programme on cold atoms and the transfer of research directly related to the discovery and synthesis of novel materials into the scientific programmes. Phase III further saw the introduction of techniques and know-how packages, whose goal was to share competences and expertise in key instrumentations and facilities used in condensed matter research.

Materials and resources

Access to a large selection of materials and a broad range of equipment is paramount to successful research in the field of MaNEP. To this end, an exhaustive catalogue of available materials and single crystals within the NCCR Network was established at the start of MaNEP. Up to four laboratories spread throughout Switzerland were contributing to a large variety of complex compounds that were available to all MaNEP members. Likewise, a list of available equipment in the MaNEP Network has been established. Both catalogues have been maintained to this date and shall be continued beyond the end of the NCCR.

Network, education and outreach

In parallel to excellence in research, MaNEP has invested large efforts in developing public awareness about the importance of developing, understanding and exploiting novel electronic materials. This was achieved through open days and participation in public events. The younger generations have been reached through the PhysiScope, a theatre-laboratory located at UniGE and specifically designed to introduce them to the excitement of scientific research. Well over 16'000 visitors have enjoyed this entertaining and interactive introduction to physics to date. Each of the three phases had a programme dedicated to exploring and promoting electronic materials for applications. This delicate balance between basic research and applications was managed within MaNEP and funded through numerous direct collaborations with industry and CTI projects. MaNEP was also very successful in getting substantial funding for applied projects through two stabilisation packages. Two industrial partners have been full members of the MaNEP Network throughout the three phases, and collaborations are due to continue beyond the end of the NCCR. During phase III, MaNEP established strong links with a full member from the University of applied sciences, HES-SO hepia, in Geneva. The scientific Network was also consolidated during phase III, in the form of a joint appointment of two full professors with PSI, whose facilities are very important to the field of MaNEP. Regular conferences, topical meetings and schools further contributed to create a strong Network among the scientists active in Switzerland in the field of MaNEP. These were also much appreciated by PhD and postdoctoral students.

2.2 Structural achievements during and beyond the NCCR

The NCCR MaNEP has had substantial structural impact on the Home institution as well as on participating institutions at various levels. The University of Geneva has significantly strengthened its position in the field of the NCCR MaNEP, establishing itself as the leading institution in Switzerland and ranking among the best in the world. UniGE has committed significant financial resources to stabilise the growth enabled by the NCCR MaNEP. Thanks to the NCCR MaNEP, UniGE has declared physics a priority area. The priority area did encompass all of physics including astronomy and was later extended to mathematics. The immediate impact of this decision has been additional operational funding and the creation of new positions at all levels from scientific collaborator to full professor. On a longer term, this led UniGE to support very strongly a large project for a state-of-the-art new Centre for astronomical, physical and mathematical sciences. This commitment should materialise, as described later in this report, in a new building that will allow, beyond scientific research, very many MaNEP activities including outreach, technology transfer and educational aspects to be further developed.

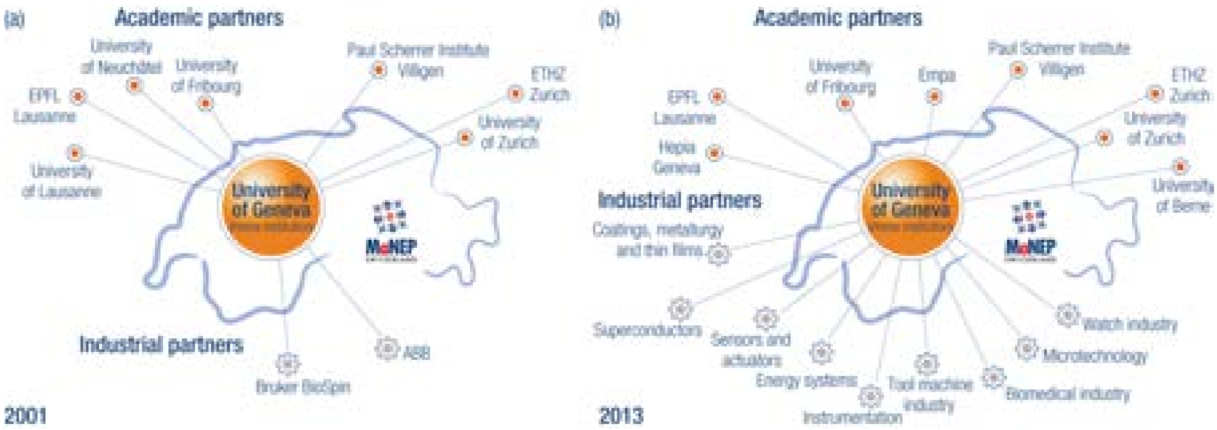

Figure 1: *NCCR MaNEP Network (a) at the beginning of phase I and (b) at the end of phase III.*

Amongst the Network partners (Fig. 1), the Paul Scherrer Institute (PSI) and the University of Fribourg saw their activities in the field of MaNEP reinforced. The connection between PSI and the MaNEP Home institution were formally strengthened through the joint appointments of two professors, Felix Baumberger (80% UniGE, 20% PSI) and Christian Rüegg (20% UniGE, 80% PSI).

Major challenges for the future research in materials with novel electronic properties are access to materials synthesis facilities and to develop materials discovery competences in Switzerland. Recent retirements have affected two of the three main crystal growth laboratories in Switzerland participating in the MaNEP Network. This aspect will be given special attention during the development of the new Centre at UniGE.

Table 1a: *Structural aspects, types and achievements — data from April 2013.*

Type of structural aspect	Output
NCCR-structures	**Home institution: UniGE** • Significant consolidation of the research in the field of the NCCR MaNEP. • Number of full professors associated with MaNEP has doubled. • New joint professorships with PSI. **Partner institutions** • PSI and UniFR have significantly increased their activities in the field of the NCCR MaNEP. • Empa has reinforced its research activities under the impulsion of L. Schlapbach (MaNEP member). • EPFL and UniZH have been able to maintain the level of activities in the field the NCCR MaNEP. • ETHZ has seen a significant decrease in the level of activities in the Department of Physics, offset by the hiring of new members in the Department of Materials. • UniL physics was merged with EPFL in 2003. • UniNE has experienced a major reorganisation with the disappearance of most of its Physics Institute, including condensed matter physics, in 2009.
Development of structural goals	• High priority has been given by the Home institution to support its NCCR scientists. • During the course of the NCCR MaNEP, UniGE has undergone major structural changes, becoming an independent body. • An agreement on objectives (*Convention d'objectifs sciences physiques et mathématiques* or COB) has been negotiated with the Geneva government, with high priority given to the NCCRs by the Home institution. • As part of this process, and over two periods of four years, UniGE has substantially increased the funding of the core topics of the NCCR MaNEP, but also of physics in general. During the second COB, mathematics was added to those benefiting from this increased support. • The Crystallography laboratory was transferred to MaNEP UniGE and reinforced through joint appointments with PSI.
*Number of created professorships per type** *(in chronological order)*	6 **new full professors** UniGE: A. Georges ETHZ: M. Troyer, J. Mesot, A. Zheludev, N. Spaldin, M. Fiebig EPFL: J. Mesot 12 **new associate and assistant professors** UniGE: P. Paruch, M. Decroux, D. Jaccard, R. Černý, Ch. Rüegg ETHZ: L. Degiorgi EPFL: M. Grioni, D. Pavuna, H. Rønnow UniBE: A. Weidenkaff UniZH : Ph. Willmott, G. Patzke 4 **new SNSF professor** G. Patzke (UniZH), Ph. Werner (ETHZ), V. Gritsev (UniFR), C. Senatore (UniGE) 6 **replacements entering MaNEP** UniGE: T. Giamarchi, D. van der Marel, Ch. Renner, C. Kollath UniNE: Ph. Aebi UniZH: A. Schilling 4 **replacements within MaNEP** UniGE: A. Morpurgo, F. Baumberger UniFR: Ch. Bernhard, Ph. Werner
*Junior Group Leaders**	1 **junior group leader (supported within NCCR)** Carmine Senatore was supported within MaNEP in the area of applied superconductivity before being awarded an SNSF professorship in 2013.

Type of structural aspect	Output
Infrastructure / platforms	**Home institution:** • **MaNEP management**: will be integrated in a new Centre for astronomical, physical and mathematical sciences. • **PhysiScope**: a theatre-laboratory open to the public since 2008, and specifically designed to introduce the younger generations to the excitement of scientific research (over 16'000 visitors in total, 4'500 per year and increasing). • **Geneva Creativity Center**: funded jointly by UniGE, HES-SO hepia and the Geneva government for a total of four years. • **SUPRA100**: an itinerant exhibition centred on a sculpture by E. Krähenbühl staging superconductivity combined with experiments describing the great potential of this fascinating state of matter. Itinerancy supported by MaNEP and a private foundation. • **MaNEP Switzerland**: a new association to maintain the successful Network established by the NCCR MaNEP. • **Nanofabrication laboratory:** new facilities including electron-beam lithography, metal deposition and state-of-the art scanning electron microscope. • **Scanning probe laboratory**: state-of-the-art scanning probe laboratory with a range of instruments operating under various conditions from room to sub-Kelvin temperatures, in magnetic fields and ultrahigh vacuum. • **Crystal growth and material synthesis facilities**: construction and equipment of 850 m^2 laboratory for material synthesis and characterisation. • **Computer facilities**: development of the computer cluster at UniGE. • **Cryogenic facilities**: MaNEP contributions to a new helium liquefier at UniGE. **Network:** • **Large scale research facilities at PSI**: financial participation to developments at the Swiss light source (new endstations), the Swiss muon source (beamlines and instrumentation developments) and the continuous spallation neutron source SINQ (neutron scattering instrumentation). • **Computer facilities**: reinforcement of the computer cluster for theory at UniFR and participation of MaNEP groups to the Swiss high performance and high productivity computing (HP^2C) initiative. **Home institution and Network:** • **State-of-the-art equipment**: advanced scanning probes, high field magnets, scanning electron microscope, SQUID, dilution refrigerator, laser ARPES.
NCCR-Network	**Home institution:** • UniGE **MaNEP Network (academic institutions):** • EPFL • UniL (until 2003, merged with EPFL) • UniFR • UniNE (until 2009, MaNEP activities transferred to UniFR) • ETHZ • UniZH • UniBE (since 2005) • PSI • Empa (since 2004) • HES-SO hepia (since 2009) **MaNEP Network (main industrial partners):** • ABB • Bruker BioSpin • Phasis (since 2004) • SwissNeutronics (since 2005) • GF AgieCharmilles (since 2009) • Swatch Group R&D SA, division Asulab (since 2009) • Vacheron Constantin (since 2009) • Sécheron SA (since 2009) • Kugler Bimetal SA (since 2010)

Type of structural aspect	Output
Type of structuring	Creation of a new Centre for astronomical, physical and mathematical sciences. Creation of MaNEP Switzerland, a new association to carry on the Network activities of the NCCR which has become an important network in Switzerland.

* refer to NIRA report Nr. 8010

Table 1b: *Structural aspects, sustainability per type — data from April 2013.*

Type / format	sustainability / impact (optional)
Sustainability post-NCCR-structures	Creation of a new Centre for astronomical, physical and mathematical sciences. Merging of the Geneva component of the NCCR MaNEP with the existing Department of Condensed Matter Physics (DPMC) into a new structure.
↳ *Funding post-NCCR-structures*	• Funding for the **merged MaNEP/DPMC structure** has been committed long term by the Home institution. • Long-term funding has also been committed for the new **Centre for astronomical, physical and mathematical sciences** by the Home institution, additional resources will be provided through external funding sources (e.g. sponsors, public-private partnerships). • **Geneva Creativity Center**: funded jointly by UniGE, HES-SO hepia and the Geneva government for a total of four years, supported by the *Office de Promotion des Industries et des Technologies* (OPI) and the *Union Industrielle Genevoise* (UIG). • **PhysiScope:** funded in collaboration with the Physics Section and a private foundation. Timely support for special events given by the Faculty of Science and UniGE.
↳ *Legal / institutional form*	Integration into the Faculty of Science of UniGE.
*Sustainability of professorships**	• Henrick Rønnow (EPFL) who had a tenure track obtained a permanent position. • Greta Patzke (UniZH), SNSF professor until April 2013, obtained an associate professor position. • Vladimir Gritsev (UniFR) SNSF professor until 2014. • Carmine Senatore (UniGE) SNSF professor until 2018, appointed associate professor at UniGE until 2018.
*Careers Junior Group Leaders**	—
Sustainability infrastructure	• **PhysiScope laboratory:** funded in collaboration with the Physics Section and a private foundation. Timely support for special events by the Faculty of Science and UniGE. • **The following infrastructures have all been permanently integrated into their host institutions**: Nanofabrication Scanning probe laboratory Crystal growth and material synthesis facilities Computer facilities Cryogenic facilities Large scale research facilities at PSI
↳ *Access to infrastructure for former NCCR participants*	Privileged access (with reduced fees) to the members of the new MaNEP Switzerland association.

Type / format	sustainability / impact (optional)
Sustainability NCCR-Network	Many aspects of the NCCR Network will continue beyond the termination of the SNSF funding. **Scientific collaborations** are on-going and will continue for many years. The two joint full professor appointments between UniGE and PSI are just one concrete example of this commitment. **MaNEP Switzerland** is a new association created to continue the conferences, summer and winter schools, topical meetings, internships, and doctoral school established and developed during the NCCR MaNEP. Its activities will be publicised through a newsletter and funded through membership fees, institutional contributions and external sponsoring. **Materials and equipment databases** shall be maintained and made available through the association MaNEP Switzerland.

* refer to people listed in NIRA report Nr. 8010

2.3 Financial and personnel resources

Over the twelve years duration of the NCCR MaNEP, the total funding has exceeded 207 MCHF. Several remarkable facts emerge from Table 2. Firstly, there has been a continuous and very substantial increase in the self-funding of UniGE, testifying to the strong commitment of the Home institution. Secondly, the self-funding from project participants has steadily increased, amounting to 2.5 times the SNSF budget over the three phases (Fig. 2a). This demonstrates the great value and attractiveness of the MaNEP Network to the Swiss condensed matter physics community. The substantial support of the Home institution and the self-funding of project participants contribute to nearly 70% of the overall NCCR budget over the twelve years. During phase III, these contributions went well beyond a simple compensation of the planned reduction in SNSF funding. The large increase in self-funding from project participants is a testimony to the strategy of the NCCR MaNEP, which has been to federate and strengthen the domain of materials with novel electronic properties throughout Switzerland.

Funding sources	Phase I	Phase II	Phase III	Phases I – III
SNSF funding	18'350'934	18'207'422	12'985'653	49'544'009
Self-funding UniGE	3'050'000	4'618'629	14'106'353	21'774'982
Self-funding from project participants	25'868'835	38'024'325	58'421'006	122'314'166
3rd party funding	3'391'776	5'462'739	5'352'425	14'206'940
Total	**50'661'545**	**66'313'115**	**90'865'437**	**207'840'097**

Table 2: *Funding sources of the NCCR MaNEP for the phases I, II and III — data from March 2013/IR 12.*

Industrial collaborations and KTT efforts were well supported by the NCCR throughout the Network. On two occasions, additional funding was made available by the SNSF for applications (partially included in the SNSF funding in Table 2). The *economic stimulus package* in 2009 was distributed among four selected projects for a total of 1'407'704 CHF. The *transfer projects (strong Swiss franc package)* of 2'317'000 CHF were used to support five projects from June 2012 till June 2014. The beneficiaries were selected by an internal committee. While the four *economic stimulus package* projects were managed centrally through the MaNEP management, the *transfer projects*, except one, are managed by the individual selected groups.

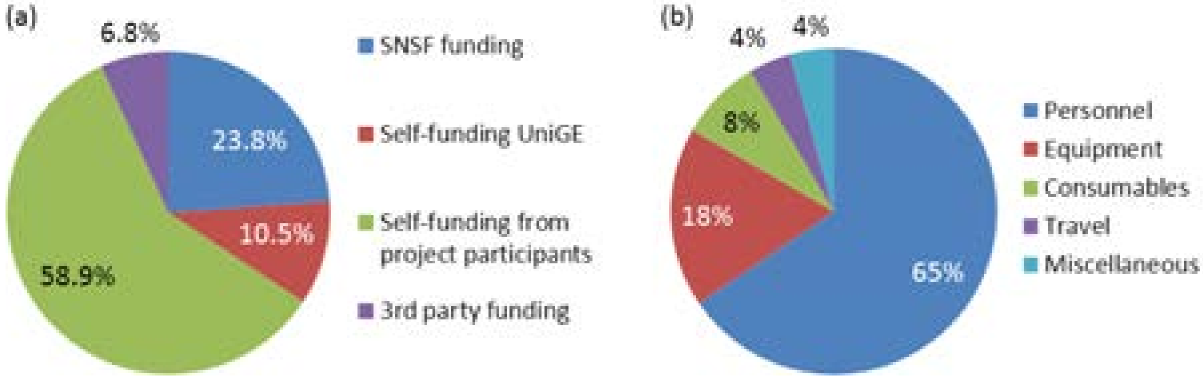

Figure 2: *(a) Distribution of total funding sources of the NCCR MaNEP. (b) Total SNSF funding subdivided by type of costs — NCCR MaNEP data from March 2013/IR 12.*

At the Home institution, the NCCR has been a fantastic boost to develop research in the core area of MaNEP. Phase I started with four full professors from UniGE associated to MaNEP. This number was increased to nine by the end of phase III, one full professor position being shared in two joint appointments with PSI. In addition, there have been five hiring and promotions at the level of associate professor, several senior researchers (*maîtres d'enseignement et de recherche*) and research assistants. The NCCR funds have been priceless in allowing the Home institution to offer competitive start-up packages for the new professors, illustrating the importance of the NCCR programme in supporting the infrastructures necessary to carry out the scientific programme. By the end of phase II, new scientific equipment in the amount of 1.6 MCHF had been installed, with the Home institution allocating 1'050 m^2 of additional floor space to MaNEP. During the same period, the Home institution increased the MaNEP budget for personnel and consumables in Geneva by 750'000 CHF.

During phase III, UniGE committed a large budget increase for MaNEP. Some partner institutions also committed important support, boosting the total MaNEP budget for phase III to over 90 MCHF. This is 37% more than the total budget of phase II despite the 8.4 MCHF (45%) reductions in SNSF funding (10.1 MCHF for phase III). At the beginning of phase III, the MaNEP Forum decided to favour the MaNEP Network rather than reducing the number of individual projects; 13 new full members and 14 new associated members were welcomed to the Network, bringing the total number of Forum members to 51 full members and 17 associated members. 600'000 CHF additional funds contributed by MaNEP partner institutes were used to add four new younger members to the Network — Tilman Esslinger (ETHZ), Anke Weidenkaff (Empa), Greta Patzke (UniZH) and Henrik Rønnow (EPFL) — in perfect agreement with SNSF regulations and the strategic choice of the Forum to promote the Network aspects rather than individual high profile research during phase III.

UniGE gradually took over the management staff leading to a significant reduction in the SNSF budget allocated to management during phase III. At the same time, a general effort was made at the Rector's office, the Faculty of Science and the Physics Section to stabilise the NCCR's achievements. The Home institution budget for MaNEP was increased by 500'000 CHF per year between 2009 and 2012, to reach a consolidated additional annual budget of about 2'000'000 CHF in 2012. The Faculty of Science contributed by increasing the running budget by 337'874 CHF and transferring the *La-*

boratoire de cristallographie to the MaNEP structure at the Home institution. Over the twelve years, the total budget for MaNEP-oriented research in Geneva has nearly doubled. But the NCCR did not only benefit MaNEP at the Home institution, it also had a significant impact on the Faculty of Science with over 2'450'000 CHF in additional budget for mathematics, astronomy and non-MaNEP domains in the Physics Section between 2010 and 2015.

A significant fraction (65%) of the SNSF funding was spent on personnel (Fig. 2b). Nearly 20% of the SNSF funding was spent on equipment, with a significant proportion specifically reserved for equipment in Geneva (Fig. 3). These were key resources to upgrade equipment and develop new laboratories. They further proved essential to attract and install the new "MaNEP" professors in Geneva. Support for equipment by the NCCR was also very effective for MaNEP partner institutions and universities, with a significant multiplier effect illustrated in Fig. 3b for equipment above 20'000 CHF purchased during phase III. About 8% of the funding has been spent on consumables and 4% were dedicated to travels. On this latter point, it should be noted that the MaNEP support has been very important to allow PhD and postdoctoral students to join conferences and workshops to present their work and integrate progressively the community.

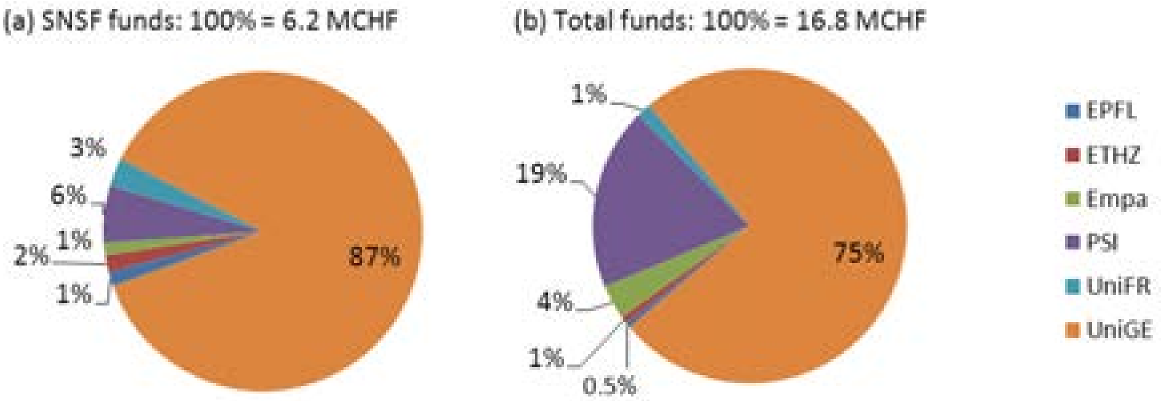

Figure 3: *Multiplier effect of NCCR equipment funds for the MaNEP Network (equipment items over 20'000 CHF). (a) SNSF funds allocated for equipment during the three phases of MaNEP. (b) Total funds available for equipment during the same period including self-funding.*

An overwhelming part of all funds available to the NCCR MaNEP has been spent on research, with only 9% dedicated to management (Fig. 4b). The shares are somewhat different when considering only SNSF resources (Fig. 4a). This difference is due to the fact that the MaNEP management was used intensively to promote the NCCR Network through conferences, topical meetings, doctoral schools, public events and outreach activities. The management was also heavily involved in knowledge and technology transfer and providing management support to all members throughout the Network. If we consider only the SNSF support to the NCCR, nearly three quarters of the twelve years funding went to the Home institution (~36.2 MCHF) and one quarter to the Network (Fig. 5a). This distribution is much more evenly distributed after deduction of the SNSF funds used to manage the entire Network at the Home institution, with 52% going to the Network and 48% to the Home institution during phase III (Fig. 5b — NIRA does unfortunately not allow to extract this detailed information for phases I and II)

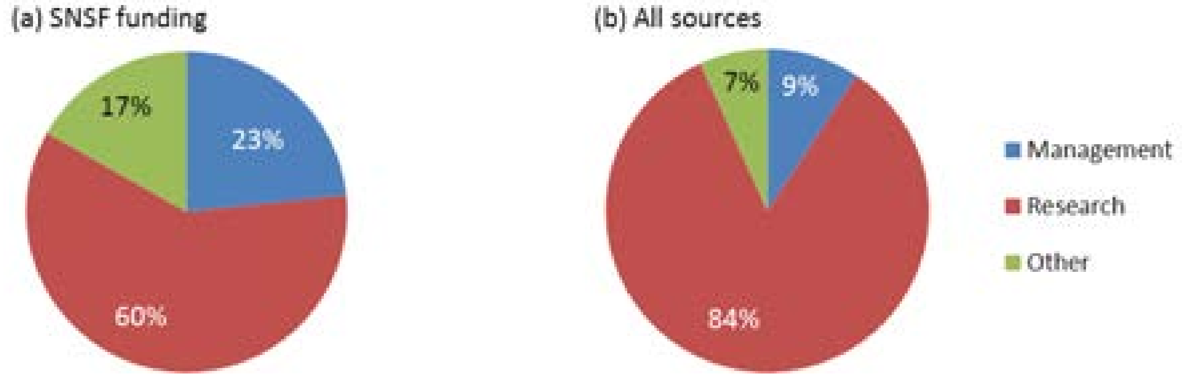

Figure 4: *Division of costs for management (incl. knowledge transfer, education, communication), research projects and other purposes (equipment, collaboration) — NCCR MaNEP data from March 2013/IR 12.*

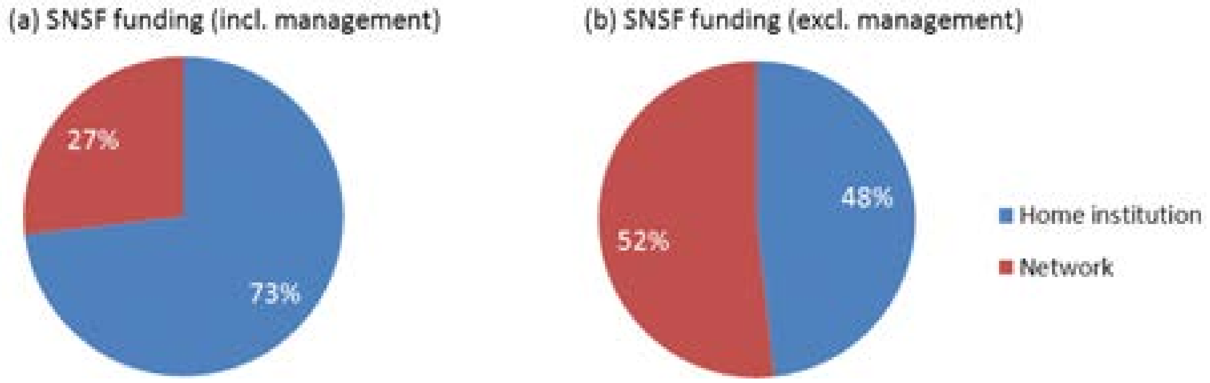

Figure 5: *(a) Distribution of SNSF funding between the Home institution (incl. management) and the Network — allocation level: projects; NCCR MaNEP data from March 2013/IR 12. (b) Distribution of SNSF funding between the Home institution (excl. management) and the Network — allocation level: groups limited to phase III; NCCR MaNEP data from March 2013/IR 12.*

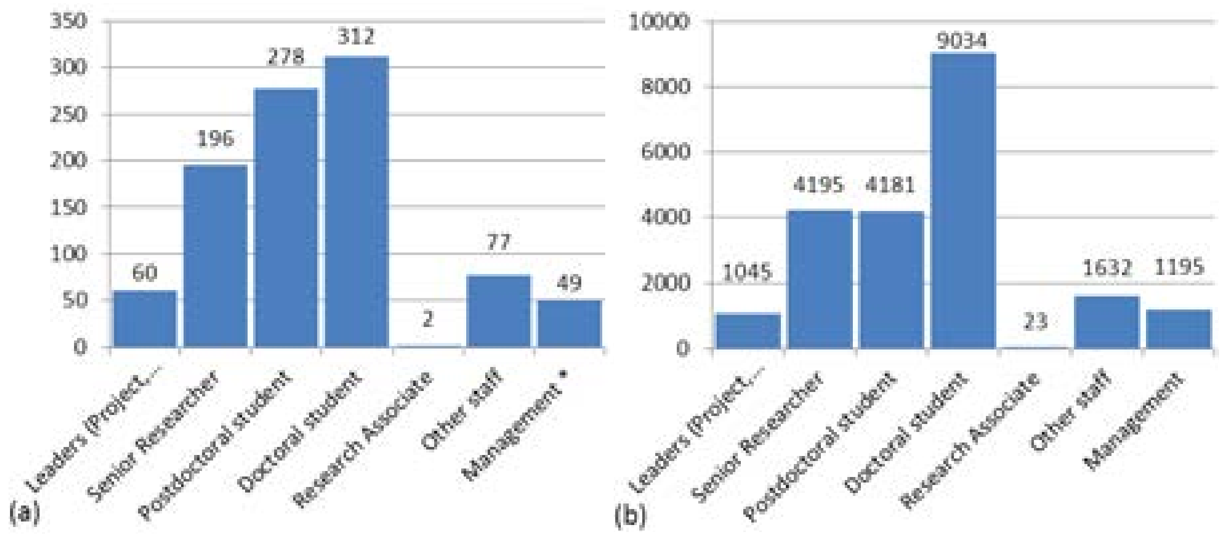

Figure 6: *(a) Number of persons per function over twelve years (* the management basically consists of 9 functions (about 7 full time equivalents), the number in the statistics contains changes of personnel). (b) Person-months per function over twelve years — NCCR MaNEP data from March 2013/IR 12.*

The great majority of personnel spending were allocated to supporting doctoral and postdoctoral students throughout the Network. Fig. 6a reflects the strong commitment to education of the NCCR, with an excellent level of supervision. The attractiveness of the NCCR is also apparent in the person-months credited to PhD students and post-docs. The former totalled 9'034 work months while postdoctoral students worked for a cumulated 4'181 months (Fig. 6b). Sixty individuals were on leadership positions, corresponding to the group leaders during the three phases. Management was kept at a minimum, with forty-nine persons assigned to nine distinct managerial functions during the twelve years and primarily devoted to finance, workshop and schools organisation, communication, outreach activities, reporting and technology transfer. Other staff includes administrative and technical staff within the research groups.

Most represented nations

	Total persons	CH	DE	FR	IT	RU	CN	Other nations
Management	49	36	2	4	7	1	1	7
Doctoral students	312	108	45	21	31	6	12	94
Postdoctoral students	278	41	37	44	33	11	8	109
Research associates	2	0	0	0	0	0	0	2
Senior researchers	196	66	25	13	11	15	4	66
Other staff	77	57	3	5	5	0	0	11
Total	**903**	**302**	**106**	**84**	**81**	**31**	**24**	**274**

Table 3: *Most represented nationalities of the personnel over twelve years — NCCR MaNEP data from March 2013/IR 12.*

The largest single country represented in the personnel is Switzerland, followed by Germany, France and Italy. Table 3 clearly shows that beyond supporting a fruitful Swiss Network, the NCCR MaNEP was also very international, with 67% of the personnel coming from outside Switzerland. This ratio even reaches 85% when considering postdoctoral students. The latter were rather evenly distributed among Switzerland, France, Germany and Italy. A large number of students and postdocs came from other countries, evenly distributed among 38 nationalities.

2.4 Management

The administration and financial accounting of the NCCR, as well as the scientific reporting, technology transfer and communications were under the direct responsibility of the NCCR director. He was assisted in these tasks by deputy directors, an administrative officer, an accountant, a communication officer, a KTT officer, scientific collaborators and a secretary in the central administration of MaNEP. Support regarding intellectual property rights, collaboration contracts and legal advices concerning the NCCR was provided by a KTT officer and the technology transfer office of UniGE (UNITEC). The large number of participating scientists in phase III and the growing number of outreach events required the hiring of additional support staff in the central administration. It also prompted the setup of a new cost accounting scheme on SAP at UniGE.

Internal control was based on half year reports and meetings of all partners and the NCCR management. The new NCCR Integrated Reporting Application (NIRA) was installed in January 2003. At the start of phase II, new accounting reports were created to give each group leader an overview of the projects he was involved in. A unique monthly report was sent to each group leader with detailed balances by projects including yearly budgets, incurred expenses for the month and a total balance. Funds provided for KTT through the *economic stimulus package* (2009) and *transfer projects* (2012) were allocated to MaNEP projects in a competitive process by internal committees.

The introduction of NIRA 2.0 during year 9 resulted in a very high workload due to the large number of new participants in phase III. The transition from NIRA to NIRA 2.0 took nearly 100% of the administrative manager's time, checking the data and helping the SNSF identifying numerous structural errors in the first release of NIRA 2.0. As a result, there was not enough time between the completion of the financial report for year 8 and the next one. NIRA 2.0 is a high performance tool, but very labour intensive on participating scientists asked to provide many detailed information. This work load was not really in line with the financial support received (typically 37'500 CHF per year during phase III), and one should aim for a better balance between funds distributed and the associated administrative efforts for individual scientists. At this point, we would like to emphasise the excellent and friendly relationship established with the SNSF, in particular with Stefan Bachmann who was always very helpful and cooperative.

During phase I, the scientific management of MaNEP relied on an advisory board and a Forum. The Forum (Annex 7) is the assembly of the senior scientists participating in the NCCR MaNEP. The advisory board had a combined executive and advisory role during phase I. This potentially conflicting situation was clarified with the introduction of a scientific committee and an external advisory board at the beginning of phase II. The scientific management was conducted in regular meetings of the scientific committee and one or two meetings per year of the Forum. The new advisory board (Annex 8), composed of outstanding international scientists, convened every two years to assist the director with an independent view on the NCCR activities, providing critical advice on modifying projects or redefining long terms goals.

Entering the last five months of the NCCR MaNEP, its director Prof. Øystein Fischer suffered a severe stroke. Deputy director Prof. Christoph Renner took over as interim director to conduct the NCCR through the last months of federal funding and final reporting, assisted in this task by a very well-organised and functional central administration of MaNEP.

3. Scientific achievements and international visibility

3.1 Major scientific contributions – goals and accomplishment

3.1.1 General aspects of the scientific research

The main goal of MaNEP was to achieve drastic improvements in the fundamental understanding and control of the electronic properties of new materials, with the long-term ambition to asses and exploit their technological potential. In the initial proposal, the main research objectives were structured into five interrelated programmes, addressing material systems (e.g. transition metal oxides, electronic interfaces, new two-dimensional systems), physical phenomena (e.g. high-T_c superconductivity, magnetism, transport), techniques (e.g. spectroscopy, material growth, large facilities), and applications (e.g. superconducting cables, neutron optical systems, power switches). Even though the specific individual programmes were reorganised in phases II and III to respond to developments in the field, the focus remained on the overarching objectives of MaNEP that were pursued throughout the duration of the NCCR.

Enabling a rapid response to unexpected developments has been one of the important strengths of the NCCR funding scheme and MaNEP. It has been achieved by providing a unique complementary expertise in the Network of Swiss researchers, and through the effective use of research funds to gain flexibility. MaNEP support had a seed fund factor with significant impact on infrastructure through the entire Network (Fig. 3). The complementary expertise available in the MaNEP Network is illustrated by the combination of experimentalists and theorists: while the two have not always directly addressed precisely the same problem, their collaboration has been essential and has always provided clear mutual benefits — to interpret experiments, suggest new ideas, and identify directions for future research. Attention to potential future applications of new electronic materials remained present in every phase of MaNEP. It has revolved around superconducting materials in the first phase, and has encompassed a broader class of materials in the later phases. Numerous cooperation with industrial partners have been established.

Over the duration of MaNEP, all these aspects have enabled the Swiss community working on novel electronic materials to be competitive at the top international level. Except possibly for Japan, no other individual country — not even the USA — has had such a prominent role in this area of research over the last decade.

3.1.2 Selected scientific domains

Many remarkable results obtained within MaNEP, or in collaborations between MaNEP scientist and external partners, have attracted attention at the international level. Here, we briefly mention a few salient results and themes that had a particularly strong impact in the field of MaNEP. They provide a snapshot illustrating significant developments in the exploration of electronic materials. They partly cover the 25 selected publications listed in Annex 1, and are necessarily incomplete due to the limited space available in this report.

Understanding strong-correlations in new electronic materials — Interactions between electrons and strong correlations in electronic systems are only poorly understood, even though they play a crucial role in determining the properties of many new materials. The exploration of specific material classes to understand in some detail the experimental manifestations of correlations is essential to progress. To this end, a large effort has been devoted to the discovery and characterisation of novel phases in unconventional superconductors since the beginning of MaNEP. One of the exemplary cases is the heavy fermion superconductor $CeCoIn_5$ where MaNEP teams have given essential contributions over the years. Neutron scattering at PSI played a key role in exploring the properties of this superconductor in a magnetic field. Early experimental results showed unusual features: in high magnetic fields, superconductivity is destroyed abruptly through the so-called paramagnetic limiting effect. Moreover, a novel phase was discovered which was suspected to be the long-sought realisation of the Fulde-Ferrel-Larkin-Ovchinikov phase (FFLO), where the superconductor forms a spatially modulated pattern, at low temperatures and high magnetic fields. While the identification of the FFLO phase remains controversial to this day, neutron scattering experiments at PSI have contributed to elucidating some most intriguing aspects of $CeCoIn_5$. Specifically, it was found that a magnetic state, spatially modulated with a regular wave length incommensurate with the crystal lattice, coexists with superconductivity. This is the so-called "*Q*-phase". Although prior to this work NMR studies from a US team hinted already at the presence of magnetic order, only the PSI neutron scattering results could establish the details of the specific order and its structure. This subject has generated considerable interest and continues to enjoy international attention.

High-T_c superconductivity — The quest for an understanding of the phenomenon of high-T_c superconductivity is one of the major challenges of contemporary physics. Contributing to this quest through a focused effort has been one of the central objectives of MaNEP. Superconductivity consists in the dissipationless flow of electrical current, an amazing phenomenon that emerges when electrons bind into pairs and form a condensate. Pairs form because electrons are coupled to collective modes, such as vibrations of atoms in the lattice (phonons), spin fluctuations (magnons), and charge fluctuations (other collective modes are also possibly relevant). In many "conventional" superconductors phonons contribute to the pairing interaction. In high-T_c copper oxide and iron-pnictide superconductors, the dominating interaction is the on-site Coulomb repulsion U on the transition metal atom. An important consequence is that electrons are strongly coupled to spin and charge fluctuations, with energy scales ranging up to U, i.e. several electronvolts (eV). Scanning tunnelling microscopy (STM), angle-resolved photoemission spectroscopy (ARPES), and optical spectroscopy experiments in MaNEP have provided strong indications that the pairing mechanism in high-T_c superconductors involves fluctuations which are mostly electronic in nature. Among other things, the observed fluctuation energy was found to range up to 0.5 eV, which is compatible with the spin- and charge-fluctuation scales, but not with phonons which are situated below 0.1 eV. The transition temperatures, calculated from the fluctuation density of states extracted from optical spectra, correlate well with the actual magnitude of T_c and its dome-shaped doping dependence.

The main aspects of the physics related to the on-site Coulomb repulsion, such as magnetism, are captured by the Hubbard model. Whether the Hubbard model can also explain superconductivity has long remained an open question. In the pre-MaNEP period, a proof of principle of the pairing mechanism based on the Hubbard model had been given by T. M. Rice for a specific ladder arrangement of the atoms. For a square lattice crystal structure, relevant for the high-T_c superconductors, no firm answer was known. Recently, developments of continuous-time auxiliary field quantum Monte Carlo algorithms have improved the performance of dynamical mean field theory solvers for the Hubbard model by orders of magnitude. This increases considerably our understanding of the various mechanisms by which high-T_c superconductivity can be obtained, a progress which is the fruit of a worldwide effort in which the MaNEP collaboration has played — and continues to play — a key role.

Bose condensation in quantum magnetism — The twelve years of MaNEP have been an exciting period for magnetism, and MaNEP has contributed very significantly with a number of ground breaking achievements. The investigation of gapped antiferromagnets in an external magnetic field has revealed remarkable phenomena best understood as instabilities of bosons. In dimer-based antiferromagnets, dimers form singlets in the absence of a field, and the excitations consist in promoting singlets into triplets. An external magnetic field lifts the degeneracy and brings one of the triplets down, resulting in a gap closing concomitantly with an abrupt change of the excitation energy of the other triplets, as observed in $TlCuCl_3$. The triplets can be considered as hard-core bosons, on which the magnetic field acts as a chemical potential, and, up to small perturbations that break the spin rotational symmetry, the transition can be interpreted as a Bose-Einstein condensation (BEC) of triplets. In the condensed phase, the interactions between triplets can, under appropriate circumstances, drive the system into a Wigner crystal, an insulating phase akin to a Mott insulator first observed in high-field nuclear magnetic resonance (NMR) experiments in $SrCu_2(BO_3)_2$. In magnetic terms, these phases show up as magnetisation plateaus.

New experimental probes for elementary electronic excitations — A key breakthrough has been the development of resonant inelastic X-ray scattering (RIXS) to probe elementary excitations in solids that are not otherwise easily accessible experimentally. Among others, RIXS enables probing the dispersion of orbital and magnetic excitations. For magnetism, it can be considered as a useful alternative or complement to inelastic neutron scattering. This has been demonstrated experimentally by the measurement of the spin-wave dispersion of $Sr_2CuO_2Cl_2$ which open new fascinating perspectives for the investigation of magnetic as well as orbital excitations. For instance, separate spin and orbital excitations in Sr_2CuO_3 have been detected. Magnetic X-ray scattering is also playing an important role in investigating ground state properties. For instance, it was particularly useful in detecting exotic order parameters such as “toroidal moments”, which are not visible in neutron scattering. A very important effort has addressed interactions between magnetic and lattice degrees of freedom, including the multiferroic effect. Particularly relevant is the pioneering work done on $RbFe(MoO_4)_2$ and $Ni_3V_2O_8$, where it was shown how incommensurate magnetic structures that break inversion symmetry can be directly liable for spontaneous electric polarisation. It is also thanks to the motivation provided by these MaNEP-driven activities — that have constantly stimulated progress in experimental techniques — that the infrastructure at PSI to perform RIXS experiments are now among the best in the world.

Electronic interfaces — The exploration of the electronic properties of $LaAlO_3/SrTiO_3$ heterostructures, which has led to the discovery of superconductivity at the interface between two good band insulators, has been one of the most widely publicised breakthroughs in the research done within MaNEP. It has also provided an excellent example of collaborative work exploiting the complementary expertise existing within the Network, with as many as five teams from three institutes collaborating. The field started in 2004, during the first phase of MaNEP, with the discovery by Ohtomo and Hwang that the interface between the two band insulators $LaAlO_3$ and $SrTiO_3$ behaves as a good metallic conductor. In 2007, a MaNEP – University of Augsburg collaboration discovered that this interface is also superconducting, with a T_c of about 300 mK. This same collaboration demonstrated for the first time that superconductivity can be switched on and off reversibly with a gate voltage, enabling the system phase diagram to be mapped out. A series of experiments determined the thickness of the electron gas, revealed the presence of a tuneable Rashba spin-orbit coupling, and observed Shubnikov-de-Haas oscillations in high mobility samples, demonstrating the two-dimensional nature of the electronic system. Even more recently, MaNEP groups addressed the possible presence of a polar interface, determined the electronic structure of the system, and confirmed that the formation of the electron gas is due to the polar discontinuity at the $LaAlO_3/SrTiO_3$ interface. It is clear that the $LaAlO_3/SrTiO_3$ heterostructure is just the most successful example of new electronically active interfaces. Other examples of interesting interfaces that have been either discovered or investigated actively within MaNEP, are ferroelectric domain walls and heterostructures of organic semiconductors, both exhibiting much larger conductance than expected from the properties of the constituent materials.

Materials for future electronics — Combining nanofabrication techniques with new materials is a line of research that was virtually non-existing at the start of MaNEP, although this topic had been planned as part of the original NCCR proposal. To this end, dedicated infrastructure (including electron-beam lithography and metal deposition) has been developed, along with the associated technical expertise. MaNEP activities have concentrated on the realisation and investigation of nanoelectronic devices based on new materials, or on materials that have potential for future electronic applications. Over the period of the NCCR, a variety of important discoveries, for which the realisation and investigation of nanodevices are playing a key role, have fully confirmed the validity of this strategy. Examples include graphene and topological insulators, as well as other atomically thin two-dimensional electronic systems obtained by exfoliation of bulk crystals, all areas in which MaNEP members have been active. Nanofabrication techniques have also been used in conjunction with electronic interfaces based on transition metal oxides, and to realise devices based on new electrostatic gating techniques that enable the accumulation of unprecedented densities of charge carriers at the surface of electronic materials. As the discovery of graphene clearly illustrates, the use of nanodevices for fundamental investigations of the electronic properties of new materials is essential. It is also remarkable that the directions mentioned here (graphene, topological insulators, electronic interfaces, ionic liquid gating) have appeared during the development of the NCCR, and the work that has been done is a direct demonstration of the flexibility provided by MaNEP.

Cold atoms — In the course of the NCCR, a seemingly unrelated field (atomic physics) has started to contribute to the goals of MaNEP through the realisation of “artificial solids” made of ultracold atoms trapped in optical lattices generated by interfering laser beams. Interactions and kinetic energy can be controlled in these artificial solids, enabling their use as "quantum simulators", to test theoretical models employed in the description of real materials, and approximation schemes used in their analysis. This has led to an extremely rapidly growing field, known as "cold atoms". One remarkable line of research was the development of cold atomic systems that would quantum simulate the two-dimensional fermionic Hubbard model, crucial in the understanding of many solids, and in particular of high-T_c superconductors. This was achieved by T. Esslinger and collaborators, who, prior to joining MaNEP, could probe several properties of this model, including the existence of an insulating phase driven by interactions (Mott insulator), and the occurrence of antiferromagnetic correlations. Quantitative comparisons were successfully made between the experimental results and numerical studies. Another line of research that illustrates well the fertile convergence between the cold atoms and the condensed matter communities is that of transport. In condensed matter one is used to measuring transport through systems connected to two leads, and particular successful approaches to describe such measurements were provided by the Landauer-Büttiker formalism. The realisation of a corresponding situation in a cold atom context is not straightforward and has been missing until recently. Important developments now allow addressing a class of transport problems, such as thermal transport or the transport through a two-dimensional superfluid film, that are directly akin to similar studies in condensed matter. All this experimental progress is of course strongly stimulating the corresponding theoretical activities.

Industrial applications — While the main focus of MaNEP is the fundamental understanding of materials with novel electronic properties, contributing to the development of these electronic materials for practical applications is also a key strategic objective. In practice, MaNEP has been exploring the possibility to introduce some of the materials at the focus of fundamental studies into industrial applications, focusing, among others, on high-end instrumentation, micro- and nanoelectronics, energy production and storage, sensors and actuators, tool machine industry, and watch industry. A major achievement in applied superconductivity has been the improvement of superconducting wires (e.g. based on Nb_3Sn) leading to world-class records of performance of electrical current transportation. Another remarkable success is the pioneering development of the largest critical current wire of the new MgB_2 superconductor, which could boost applications to temperature ranges that are reachable with simple cryocoolers, without requiring liquid Helium. These developments have been largely a result of a long-term collaboration with Bruker BioSpin, and have contributed to maintaining and enhancing the leading position of this company on the international market of superconducting magnets technology. Other material-based applied research worth mentioning include: the development of fault current limiter — together with ABB — for power switching, elaborated at the laboratory level; artificial superlattices that have been implemented in neutron optics components (i.e. in the components needed to focus neutron beams); artificial ferroelectric materials (PTO/STO superlattices) for a new generation of variable capacitors. Research has also successfully addressed material-based fabrication processes, such as new surface treatments for watch micro-components and a new coating technique being marketed by a Swiss tool machine company. Among all NCCRs, MaNEP has been the one with the most pronounced component of applied research, done in collaboration with a total of 28 industrial partners (15 during phase III — see Annexes 3 and 4).

3.2 International standing – goals, accomplishments and perspectives

Finding a meaningful metrics to evaluate the international standing of MaNEP in a robust manner is a challenging undertaking. While the high level of international standing of MaNEP is clearly reflected in high citation rankings and increasing number of publications in high impact journals (Fig. 7), there is a precious added value of forming a tightly knitted community in a relatively small country. Scientists in other parts of the world perceive this aspect with envy. As a result, the brand MaNEP is perceived as a highly attractive environment for PhD students and for fostering national and international collaborations.

Considering factual numbers, such as publications (Table 4), citations (Fig. 7b) and contributions to congresses and fairs (Fig. 8), MaNEP has been performing extremely well. Citations have been growing at a fast and steady pace between 2002 and 2013 (Fig. 7b — the six months in 2001 have been intentionally excluded from our statistics since those publications most likely relate to work done prior to MaNEP). The same is true for contributions to conferences and fairs (Fig. 8). Publications have been steadily shifting to higher impact factor journals over the twelve years (Fig. 7a). Several highly cited review articles authored by MaNEP scientists in well-known journals also contribute to the international standing of the NCCR. MaNEP scores an impressive h-factor of 86 after twelve years.

Type	**Number**	**Percent**
Peer review articles	2'729	88.2%
Without peer review articles	246	7.9%
Articles in anthologies	73	2.4%
Books	23	0.7%
Reports	24	0.8%
Total	**3'095**	**100%**

Table 4: *Total number of publications and percentages per category — NCCR MaNEP data from March 2013/IR 12.*

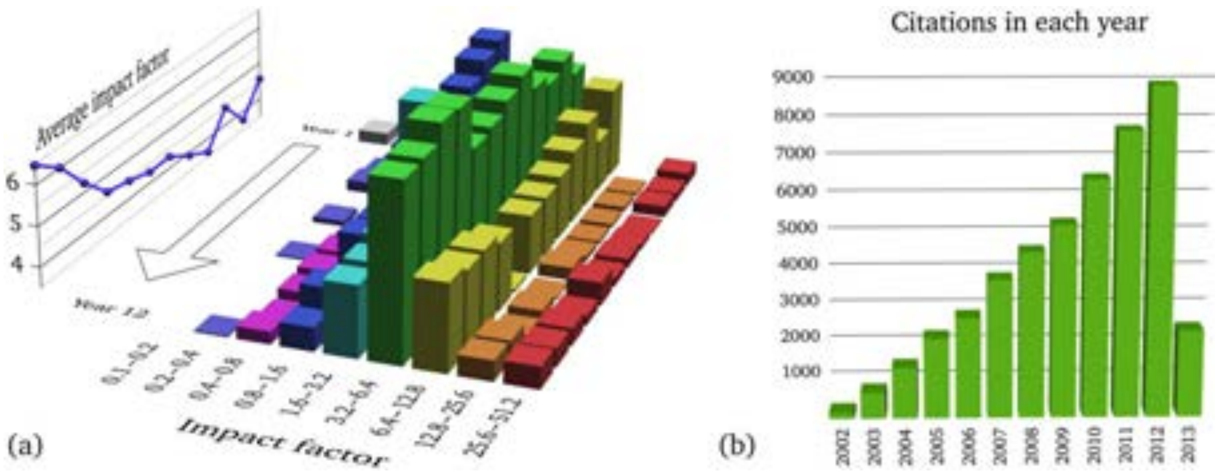

Figure 7: *(a) Number of MaNEP peer-reviewed publications as a function of MaNEP years and journal impact factor. There is a clear shift to higher impact factors with time, with a clear increase in the average journal impact factor from 3 to 7. (b) Annual citations of MaNEP publications.*

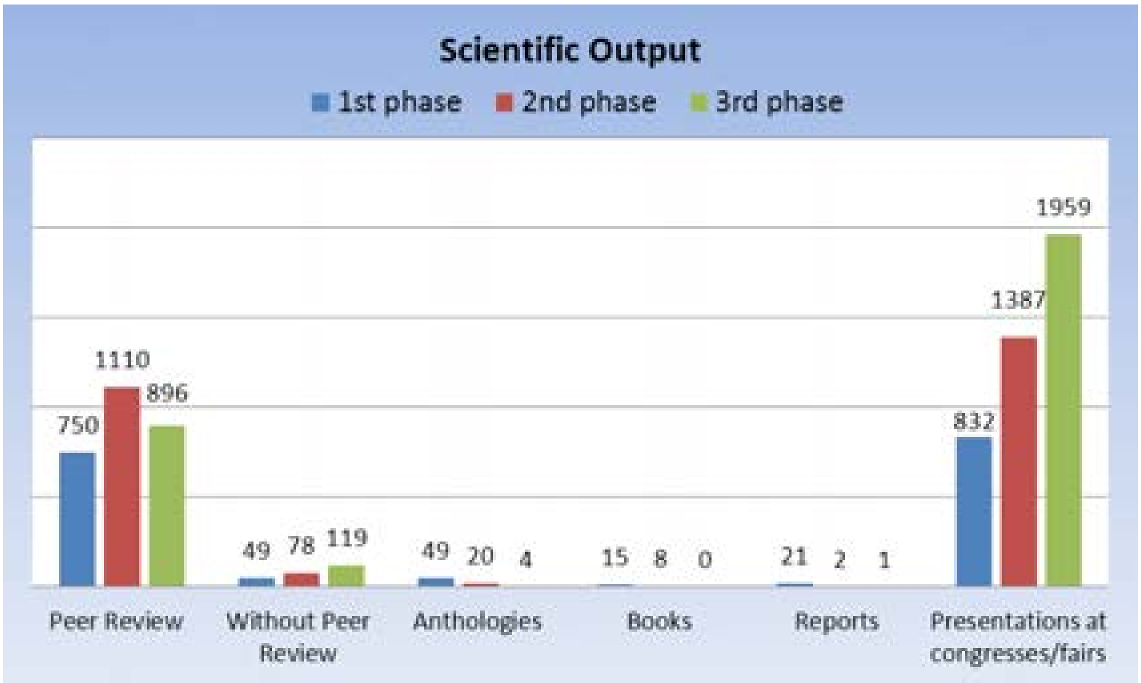

Figure 8: *Number of publications and presentations at congresses and fairs — NCCR MaNEP data from March 2013/IR 12.*

MaNEP has become a renowned label, both at the national and international level. This perception is less straightforward to measure in a quantitative way. MaNEP has been instrumental in triggering collaboration efforts, which eventually led to other national and international network programmes, for example the Sinergia programme on Thermoelectric Oxides (Annex 2). The high standing of the Swiss community in the field of electronic and magnetic properties of materials on the international scene is also measured in terms of competitive proposals for collaboration. This includes proposals at Swiss facilities such as the Swiss Spallation Neutron Source SINQ and the Swiss Light Source (SLS), and the Swiss coordination of the European flagship on graphene. MaNEP members sit in numerous international advisory boards and evaluation committees, have received prestigious prizes, have been elected to professional societies and organised well-known international conferences (for example Gordon 2004, LEES 2010). Another positive indicator of the international standing of MaNEP is the choice of Switzerland for M^{2}S-2015, the main triennial international conference on superconductivity.

MaNEP has entirely fulfilled the goal of establishing the Swiss community on the international scene as a major player in the field of electronic and magnetic properties of materials. This is not only measured in the high level of proposals for collaboration, but also in terms of high-profile visitors. The Network has been able to attract several international renowned scientists to professor positions. Table 3 further illustrates the international appeal of MaNEP in the large numbers of foreign students it has attracted.

The NCCR has had substantial added value for Switzerland and the Swiss condensed matter physics community. MaNEP contributed to the excellent international visibility, favoured synergies between experimental and theoretical groups, and triggered numerous collaborations between Swiss groups. For many researchers taking up positions in

Switzerland, MaNEP has been an important part of their integration into the Swiss community of materials-oriented condensed matter physics. This is true for those entering in tenured positions as well as non-tenured junior faculty, postdocs, and even PhD students. There has been no better way to get acquainted with the relevant researcher in our country than through a MaNEP event (workshop, school, conference). Most of those leaving Switzerland to continue their carriers abroad kept strong ties over the years with MaNEP.

The achievements of the NCCR will be maintained and developed through a new association that will resume all the Swiss Network aspects of MaNEP. At the local level, the NCCR will have a significant structural impact on the Home institution, with the creation of a new Centre for astronomical, physical and mathematical sciences. The Home institution has provided the necessary means to sustain the level and quality of activities developed during the NCCR. It has provided additional support towards a more profound reorganisation of mathematics, physics and astronomy, to bring them together into one Centre. The ambition is to foster new ideas and synergies to tackle some of the outstanding challenges of our society by merging these three disciplines. An outstanding challenge still deserving special attention is the discovery and synthesis of novel materials. MaNEP could count on four main laboratories with complementary competences. Two of them have been affected by retirements, and have either been closed or reorganised. Strengthening material discovery and synthesis will be one of the preoccupations of the new Centre.

4. Knowledge and technology transfer to economy and society

4.1 Strategy, aims and resources

The central aim of knowledge and technology transfer (KTT) is to transfer academic knowledge and expertise to companies and individuals, fostering innovation and creating commercial value. KTT has been an important component of MaNEP from the very inception of the NCCR, continuously growing over the twelve years of the NCCR programme. It started with two industrial partners — ABB and Bruker BioSpin — directly associated with one of the scientific programmes in 2001 and a strong focus on superconductivity, to reach a much broader portfolio and over 15 industrial partners in 2013, including SMEs and small companies (Annex 3). IBM who contributed to the proposal for phase I dropped out before the NCCR start due to intellectual property issues. The latter were one of the more serious difficulties encountered by the NCCR in establishing industrial partnerships. Collaborations have focused on testing and exploiting new materials, training people in modern fields of material science, gaining access to sophisticated equipment and competences.

MaNEP closely monitored its KTT activities over the years, adapting them to the evolution of the NCCR and the broader industrial and technological landscapes. The KTT activities were developed in three strategic steps during the past twelve years: first, raise the awareness about MaNEP's activities and strengthen the industrial Network with new partners; second, develop a portfolio of success stories where the contribution of MaNEP was a clear asset; third, support the applied R&D activities with increased independent funding. Two postdocs were appointed part-time during phase I, with the mission to inform about the NCCR results and technologies and seek new contacts with potentially interested industries. They developed printed material (e.g. periodic newsletters, catalogue of facilities and technological know-how), organised meetings and site visits. International visibility was achieved by the presence of KTT at international fairs (like the Hannover Messe). As the focus was shifting from mostly informing to more concrete realisations with its portfolio of success stories, a KTT manager was appointed to take care of contractual issues. He was also in charge of handling intellectual property rights and patent applications in collaboration with the local offices of technology transfer of the academic and institutional partners. Funds necessary for these positions came directly from the MaNEP management.

The third strategic step to diversify and consolidate the KTT activities was carried out through focused and clearly defined projects, creating the capacity to trigger substantial support from the industrial partners as well as from other institutions like the CTI. With the nearing end of federal funding, MaNEP took a leading role to develop two new complementary KTT initiatives in Geneva, with the creation of the Geneva Creativity Center (GCC) and the proposal for a Laboratory of Advanced Technology (LAT). The GCC is a collaboration between UniGE and HES-SO hepia supported by the *Office de Promotion des Industries et des Technologies* (OPI) and the *Union Industrielle Genevoise* (UIG). The GCC strives to bring academics and industrial research and development together to discuss their needs, ideas or problems in order to develop innovative projects taking advantage of all the tools and skills available. The LAT is a collaboration between UniGE and HES-SO hepia to provide access to state-of-the-art equipment and analysis competences to the industry. Facilitated access to sophisticated instruments to explore technological innovation is of great value to companies, removing risks at early stages of applied R&D projects.

4.2 Achievements – overall and highlights

The number of industries collaborating with MaNEP has grown continuously over the years, and most significantly during the last four years. Results, expertise, and know-how generated by basic research have been put into action and successfully transferred to economy and society. The industry has developed a positive perception for MaNEP activities, conciliating the long-term nature of basic research with the more pressing needs of industry, economy and society in general. The concerted KTT communication and outreach effort has paid off, with several industries pushing the doors of academia and spontaneously approaching the NCCR. This interest led to remarkable diversification of the applied research activities in MaNEP and broadening of industrial partners to including also SMEs and small companies. From the initial focus on applied superconductivity, applications now comprise fields as diverse as sensors, adaptive neutron supermirrors, energy harvesting and storage, advanced coatings and thin films, new materials and processes, and many more.

The KTT programme has been successful in many respects. The number of CTI projects, services and fabricated prototypes has been steadily increasing (Fig. 9). The number of patent applications, although on the modest side, was constant at nearly three per year. MaNEP has also led to one spin-off and one licence agreement, which is a positive sign for a Network more focused on fundamental than on applied research. It is impossible to provide here a complete description of all the collaborations and achievements listed in Annexes 2 to 5. The present report is focused on a few significant examples illustrating the KTT efforts of MaNEP.

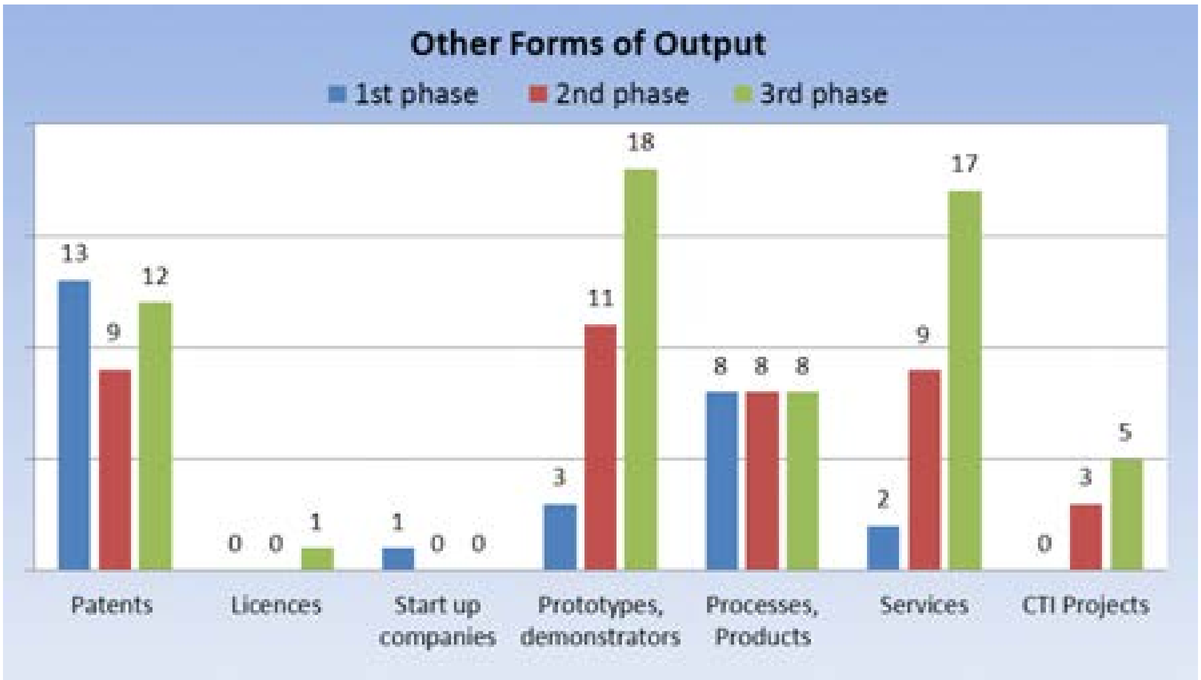

Figure 9: *Number of patents, licences, start-up companies, CTI projects, etc. — NCCR MaNEP data from March 2013/IR 12.*

The long standing collaboration with **Bruker BioSpin** (early member of MaNEP) has led to major improvements in the performance of superconducting wires. New methods for producing multifilamentary wires of Nb_3Sn were developed at UniGE, yielding the largest critical currents so far for this traditional superconducting wire material. The team at UniGE was also able to enhance significantly critical currents in MgB_2 wires, developing a method to obtain much denser wires of this new generation superconducting material. Record values of current carrying capacity have been achieved, giving Bruker BioSpin a leading edge in R&D on superconductiving magnets of all sorts. The chain of competencies required to elaborate and characterise a superconducting wire relies on a number of particular skills. Unfolding that basic research value chain, taking advantage of each segment of expertise, and matching the different competencies to particular applications is a very effective way of expanding the outreach of technology transfer activities.

MaNEP has been collaborating with **SwissNeutronics** through its scientists at PSI. This company has developed into a leading player on the neutron source and beamline market worldwide, with about twenty employees. It has specialised in neutron guides and focusing devices. Its speciality is adaptive neutron optics which allows focusing and tweaking neutrons on small samples on various neutron instruments. Numerous technological developments, especially in the field of multilayers, result directly from collaborations initiated through MaNEP.

AgieCharmilles (+GF+ corporation) is a world leader in the machine tool industry, facing fierce competition from Japanese manufacturers. In response to this competition, it had to enter the growing market of coated metal parts to maintain its leading position. Combining surface science tools, metallurgy and X-ray fluorescence analysis, a MaNEP project has met the challenge to provide AgieCharmilles with the technology it needed to manufacture substantially better tools. Carried out in the framework of the *economic stimulus package*, this development took only two years to succeed, and has supported AgieCharmilles to secure this strategic market with key customers like Apple and Samsung.

Vacheron Constantin and **Phasis**, a UniGE spin-off company created in 2004 (Annex 5), are industrialising a new marking technology developed in MaNEP. The technology is inspired from scanning tunnelling microscopy (STM) equipment and expertise. A prototype combining surface science and nanotechnology “writes” microscopic patterns made from various alloys into the surface of metal parts. Potential applications range from the implementation of secured certification hallmarks in high-end watches, marking medical tools for traceability, and chemical tagging of safety-critical aerospace parts.

Many projects and collaborations will continue past the end of MaNEP, and others are currently being negotiated. KTT efforts are to be continued after the formal end of MaNEP, either through the GCC, the LAT or similar structures in participating universities and institutes. They will benefit from the strong portfolio and experience gathered during the past twelve years. Both will be invaluable assets in the quest for new industrial partnerships. In addition to developing collaborative projects, MaNEP has also been quite successful in placing PhD and postdoctoral students in industry, both in Switzerland and abroad (Fig. 10).

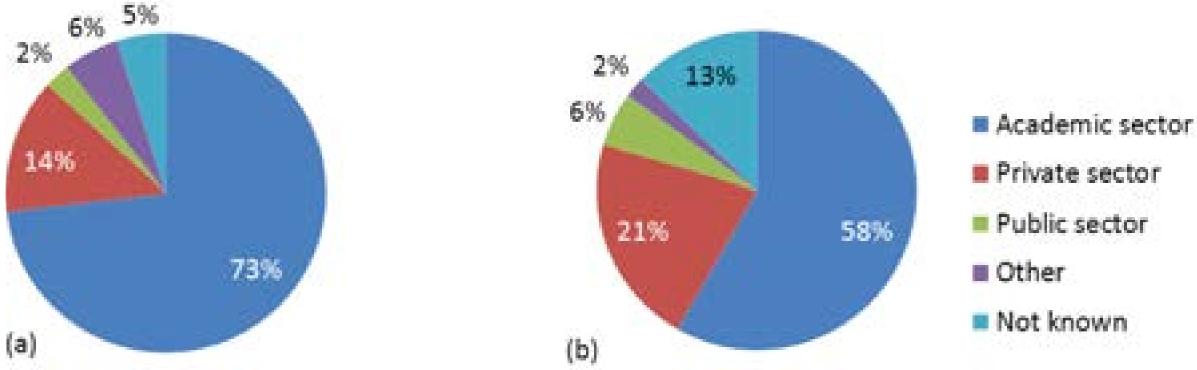

Figure 10: *(a) Next employment of PhD and postdoctoral students after leaving the NCCR — NCCR MaNEP data from March 2013/IR 12. (b) Employment at present — data from group leaders, December 2012.*

4.3 Experiences and outlook

MaNEP's KTT strategy has given excellent results in terms of technology transfer and training a new generation of industry-oriented scientists. Over 14% of students found their way into industry (Fig 10). Not only were KTT activities successful in connecting academia and industry, they were also instrumental in stimulating contacts between industrial partners. Valuable experience has been gathered towards preparing new projects with product and market orientation (e.g. CTI projects) for a sustainable activity in the future. Matching the capabilities of the NCCR with the expectations of a given industrial partner in a timely way was a crucial factor underlying the success stories reported above. MaNEP has succeeded in this endeavour without jeopardising its primary focus on fundamental "blue sky" research.

An important KTT challenge was to conciliate the time frames of scientific research with applied developments. While the former aims at exploring and publishing, the latter follows a strict planning with deliverables and milestones. Another difficulty affecting the development of KTT projects was related to the scarcity of available laboratory space at the Home institution. As MaNEP ran out of creative solutions to accommodate the increasing number of projects, the Home institution provided premises in a modern industrial zone.

Access to advanced instrumentation by the industrial partner in the NCCR Network has been a fantastic asset. Indeed, the use of modern scientific equipment can reveal unknown features susceptible to trigger new perspectives for the industry. NCCR funding to renew, upgrade and maintain such facilities has been extremely valuable with up-to-date equipment to serve our future plans. KTT activities benefit much from geographic proximity. It ensures better reactivity and inspires local authorities to provide increased support to interact with the local industries.

The role and importance of KTT in addition to education and research is relatively young at the NCCR Home institution. The creation of the technology transfer office UNITEC in 2000 has had a very positive impact and MaNEP was fortunate to receive their support and assistance in all KTT-related contractual and legal aspects. Since KTT concerns the creation of commercial value, intellectual property rights and exploitation rules have to be carefully settled and agreed for the successful completion of any project.

The MaNEP KTT activities shall be continued within new structures established or initiated during the NCCR, in particular the GCC and the LAT in Geneva. MaNEP has shown the value and return on investment of KTT, not only for the industrial partners, but also for basic research. Continuity, sustainability and growth of applied research will be achieved by targeting key industrial sectors with international reputation, where the competitiveness of our country is well recognised. Today, these sectors include very high-end technological and scientific equipments, the fine tool industry, sensors and actuators, advanced materials for the energy sector and the watch industry, all of whom are currently involved in some KTT projects.

5. Education and training – promotion of scientific careers

5.1 Strategies, aims and resources

Attracting, training and integrating PhD students and young researchers have been one of the primary and permanent concerns of the NCCR MaNEP. The substantial growth of the community over the twelve years of NCCR funding, and the large proportion of MaNEP PhD students and postdocs embracing an academic career, are clear evidences that this goal has been met with success. The efficiency of local and international scientific meetings in building and strengthening the community, promoting the exchange of ideas, and stimulating collaborative research is well established among physicists. Therefore and beyond direct financial input, MaNEP support directed at young researchers has been channelled chiefly through conferences, meetings and schools. In addition, MaNEP has been running a mobility programme, a student exchange programme and a doctoral programme introduced during phase II. These activities were supervised by two people and required the commitment of many participants in the MaNEP Network (conference and meeting programme committees, teachers) and administration (organisation of events, communication).

5.2 Achievements

SWM conference — The Swiss Workshop on Materials with Novel Electronic Properties (SWM conference) in Les Diablerets has been one of the main events to rhythm the life of MaNEP; a kind of family reunion, enriched by the contributions of invited international speakers (typically ten). In fact, the NCCR MaNEP originated in a Swiss community already meeting regularly in Les Diablerets prior to the NCCR call for proposals. With MaNEP, these meetings became a biennial gathering of typically 180 scientists, with a large place reserved in the programme for young scientists. Every MaNEP PhD student and postdoc was strongly encouraged to submit an abstract and participate. Many got the opportunity to give oral presentations, contributing to their communication skills and visibility in the Network. Those presenting a poster were given the opportunity to draw attention on their work in short one-minute advertisements in front of the audience. The SWM conferences were unique networking opportunities for all generations present. They also offered ample occasions for social and sports activities in the free time, as well as contacts with industry partners invited to present their products at the conference. MaNEP was instrumental in driving, organising and funding these meetings.

Collaboration with SPS — Since 2004, MaNEP and other NCCRs in physics have been invited every other year to join the annual meeting of the Swiss Physical Society (SPS) as special guests. MaNEP strongly encouraged the NCCR Network to participate, significantly increasing the level of participation at the SPS meetings. MaNEP became one of the leading contributors to the programme and attendance at those SPS meetings. This level of participation is particularly motivating for junior scientists and students, leaving them with the feeling to belong to one of the strong communities dedicated to physics in Switzerland.

Topical meetings — Exposure to recent discoveries and changing trends is crucial for all scientists active in a rapidly evolving field, especially when starting a career. The different topical meetings organised by MaNEP since 2003 have served that purpose. Various specialised workshops and international conferences, organised either single-handed by MaNEP or in collaboration with PSI, served the same purpose. The Martin Peter colloquium, organised every three years since 2003, was another occasion for PhD students and postdocs to meet and listen to prestigious speakers.

MaNEP schools — While scientific meetings are an essential part of the scientific life, they do not provide the necessary training for beginners to enter the field. The first major training activity organised by MaNEP was a summer school organised in Saas-Fee in 2004. All teachers and most students attending this first school were MaNEP members. The school has since been organised four more times, becoming a winter school since 2009 and open to international speakers and students. Participants' feedback has always been globally positive, with many attending the school a second time.

Mobile postdocs and student exchange programmes — With the goal of promoting the mobility of young researchers among the various MaNEP groups, a mobile postdocs programme was launched in 2003, and a student exchange programme (for master students) started in 2009.

Doctoral programme — While the MaNEP Network and activities were growing during phase II, an opposite trend was observed in Swiss universities with collapsing numbers of graduating physics students. In response to this worrying trend, MaNEP setup a doctoral school with the objective of attracting excellent PhD students from Switzerland and abroad. The programme also aimed at helping the students master their own research subject and understand the diverse experimental and theoretical activities within MaNEP. The programme was publicised through a local website and job postings in specialised websites and journals, both in Switzerland and abroad. The programme itself involved training courses and various events. After 2009, the doctoral programme was progressively merged with the *Conférence Universitaire de Suisse Occidentale* (CUSO) *3ème Cycle*, to become the CUSO doctoral programme in physics.

Activities for undergraduates and school children — Many MaNEP volunteers have contributed to various events dedicated to the promotion of science and public awareness, such as *La Nuit de la Science* in Geneva. MaNEP organised its own public events (*Suprafête*, SUPRA100) to educate and inform about its research (section 7.2). These activities were all built with the desire to show stunning physics experiments, in particular to fascinate children. To make these shows durable, among other motivations, MaNEP initiated the PhysiScope in 2007 (more details in section 7.2).

Placement of PhD students and postdocs — Fig. 11 shows the status of the PhD students in MaNEP. In total, 312 PhD contracts were signed during the twelve years lifespan of MaNEP (Table 3). This corresponds to 26 new PhD students per year on average. As the duration of graduate studies is typically four years, ⅔ of them have been completed by now. The very low failure rate of 2% underlines the good working environment and the quality of the supervision offered in MaNEP. Fig. 10 shows that ¾ of PhDs continue to work in the academic sector just after leaving MaNEP. This large proportion testifies that MaNEP graduates match the high level of qualifications required to enter an academic career. When considering how many graduates are still in academia at a later stage, the proportion reduces to 58%, illustrating the general problem of finding a permanent academic position beyond the second postdoc.

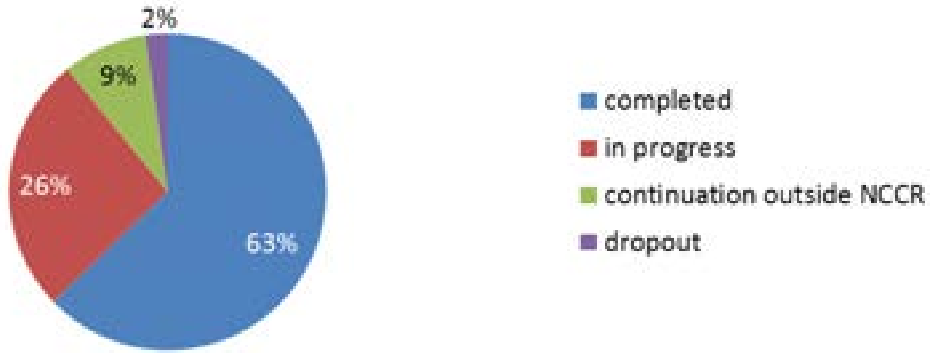

Figure 11: *Training status of the PhD students — NCCR MaNEP data from March 2013/IR 12.*

Some career highlights — **Lara Benfatto** became the first MaNEP mobile postdoc in 2003, following her first postdoc at UniFR. After a third postdoc in La Sapienza, she obtained a young researcher grant of the Enrico Fermi Center in 2006, and a permanent researcher position in the Institute for Complex Systems in Rome in 2009. **Philip Werner** graduated from ETHZ in a MaNEP group in 2006. After a postdoc at Columbia University, he became SNSF professor and returned to ETHZ in 2008. In 2012, he was appointed associate professor at UniFR. **Corinna Kollath** joined the MaNEP Network as a postdoc in 2005. Two years later, she was appointed junior research chair in the French network *Triangle de la Physique*. She became *chargée de recherche de 2ème classe* at *École Polytechnique* in Paris at the end of 2008 and was appointed associate professor at UniGE in 2010. She left UniGE in 2013 for a professorship in Bonn, Germany. **Fabrizio Carbone** left for a postdoc at Caltech after finishing his PhD within MaNEP in 2007. After his postdoc, he came back to Switzerland as a research assistant at EPFL. In 2010, he became SNSF professor and, in 2011, tenure-track assistant professor at EPFL. **Olivier Kuffer** obtained his PhD at UniGE. He then became one of the first MaNEP knowledge and technology transfer officer, in parallel to his postdoc at UniGE. He joined Phasis, a MaNEP start-up at UniGE in 2004, and ROLEX in 2006 where he is now manager at a research division.

5.3 Experiences and outlook

The benefit of hosting MaNEP has been acknowledged by UniGE on several occasions. MaNEP has been an extraordinary drive and support in developing condensed matter physics at UniGE over the last decade. The teaching activities initiated by the doctoral programme are permanent assets beyond the end of MaNEP. Training and educational activities developed by the NCCR (conferences, schools, topical meetings, and more) as well as contributions to the advancement of women will be continued in the framework of the new association created to resume the MaNEP networking activities. The PhysiScope (see section 7.2) has been institutionalised and has become one of the educational and outreach flagships of UniGE. Its activities will keep developing, in particular through collaborations with IUFE (*Institut universitaire de formation des enseignants*) at UniGE, with the Swiss Television network and international networks like EuroPhysicsFun. The PhysiScope is also spearheading efforts to extend its concept to a SciEnScope to include other scientific topics from the faculties of science and medicine.

There have also been some difficulties related to education and training within the NCCR. It was for example soon realised that collaborating with the well-established CUSO doctoral programme was a better option than setting up a complete training programme within MaNEP. At UniGE, MaNEP experimented novel procedures for the recruitment of PhD students and postdocs in the form of grouped announcements and interviews. However, it proved less performing than the traditional way where each group seeks its own collaborators. Concerning careers, dual careers remain a recurrent and stringent problem still awaiting a solution.

6. Advancement of women and equal opportunity

6.1 Strategies, aims and resources

The percentage of women in the field of physics and material sciences in Switzerland is very low at all levels, from students to professors. This proportion is even decreasing with increasing career advancement, a trend also observed in other domains. An additional difficulty is that women make up only 15 – 25% of incoming students at the bachelor and master levels. In this context, MaNEP has implemented a three pronged strategy to promote the advancement of women (AoW): i) encourage young women to study physics, ii) motivate female physics students to continue in research at the PhD level, and iii) facilitate the conciliation of professional and family life. We emphasise that these are all positive actions which do not unfairly penalise young men working in the field.

From the beginning, MaNEP has planned to give special attention to female PhD and postdoc students, monitoring the situation and participating and sponsoring a range of actions. By the end of phase I, MaNEP had setup a first set of specific AoW initiatives (e.g. summer internships) with more being deployed during phase II (e.g. the PhysiScope). All AoW initiatives were funded through the education budget and their impact was continuously evaluated. A focused survey polling all female researchers in MaNEP was conducted at the beginning of phase III to assess the situation of women in science within the Network.

6.2 Achievements

The most evident achievement of MaNEP's AoW efforts is the transition from zero to five female Forum members between 2001 and today (Fig. 12 and 13). MaNEP endeavoured to systematically associate every woman in the field recruited at the professor level with the MaNEP Forum. Thus, a total of six new female professors joined the Forum, the last two in the final two years of the NCCR. Four of the present female group leaders were trained at some point in MaNEP before joining the Forum as a professor. MaNEP thus offered these women the opportunity to realise their career goals, in perfect fulfilment of the phase II proposal statement "we envisage offering a special position for one exceptionally gifted female researcher possibly coupled with a career plan".

During the second half of phase I, summer internships in MaNEP research groups dedicated to female students in their third or fourth year of study were introduced. The primary goal was not recruitment, but an opportunity to trigger interest and help them deciding for a scientific career — many participants indeed ended up joining a MaNEP team. These summer internships spearheaded a broader reflexion on the specific challenges faced by women in physics. They were an extremely successful and cost effective achievement of the MaNEP AoW programme acknowledged by all women researchers polled in the NCCR internal survey. The relevance of such internships for the promotion of women in science and their cost effectiveness has been praised as an example by an EU FP7 programme officer in the framework of the OxIDes consortium. To extend this offer to all students, MaNEP introduced exchange programmes with equal success.

MaNEP also acted further upstream, developing actions at the high school and junior high school level to encourage young students of both genders. Special attention was given to motivate girls and young women, since their share in science and physics is already very low at the entry level to the bachelor studies. The PhysiScope and other activities described in previous chapters participate in this effort. The PhysiScope is also an outstanding platform to join forces with institutional or national events, such as the *Journée nationale des filles/Nationaler Tochtertag* that also shifted to a cross-gender action and became *Futur en tous genres/Nationaler Zukunftstag.*

The AoW actions taken by MaNEP have had a positive impact, but the percentage of women in the NCCR remains well below 50% at all levels (Fig. 12 and 13). The number of female postdoctoral students shows large fluctuations, most likely due to the limited sample set and large turnover. Most promising of all is the steady increase in the number of female PhD students, rising from under 10% in 2001 to over 25% in 2013. The latter even exceeds the percentage of female physics students at the bachelor and master levels (~20%). Another remarkable fact is the net and steady increase in the number of permanent female group leaders. We hope that these positive trends anticipate a sustained strengthening in the female representation in the fields of MaNEP, encouraging girls to embrace studies and a career in physics or material sciences.

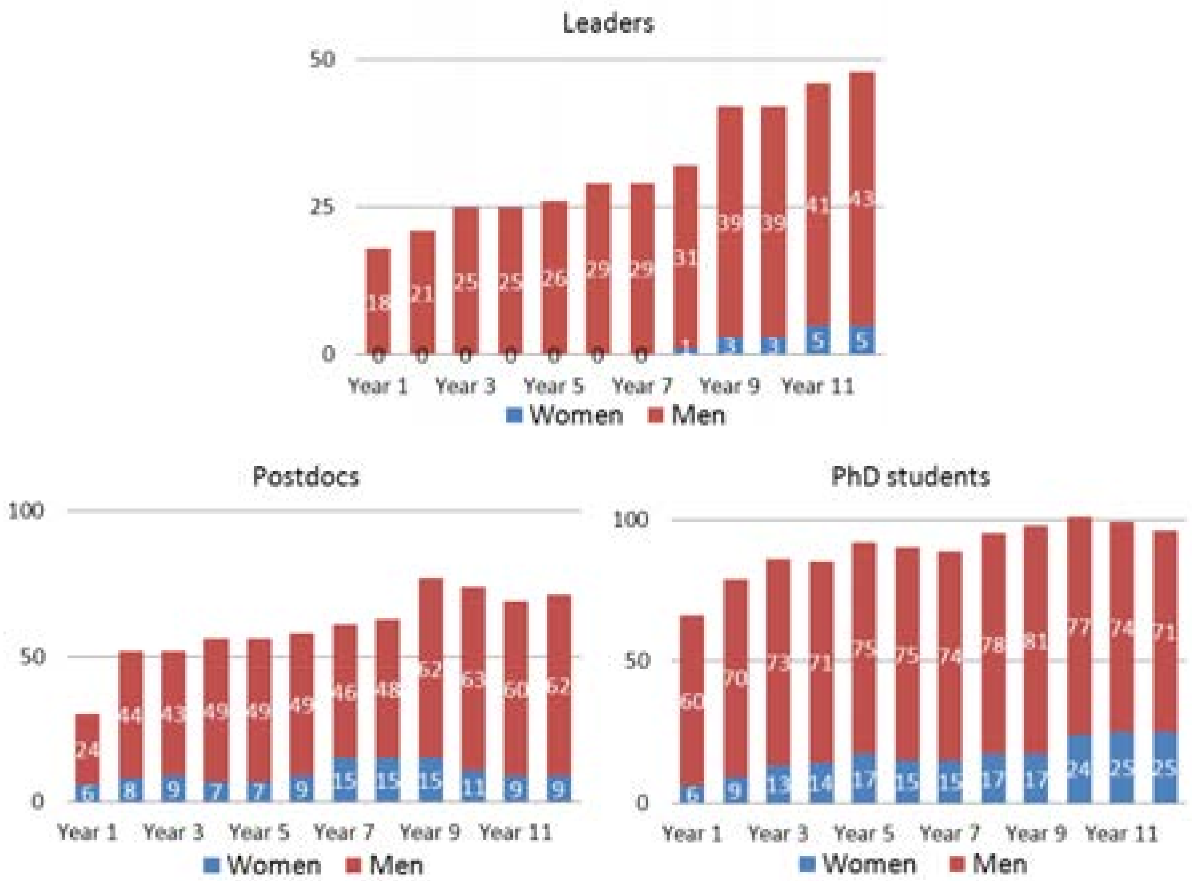

Figure 12: *Number of male/female leaders, postdocs and PhD students in years 1 to 12 — NCCR MaNEP data from March 2013/IR 12.*

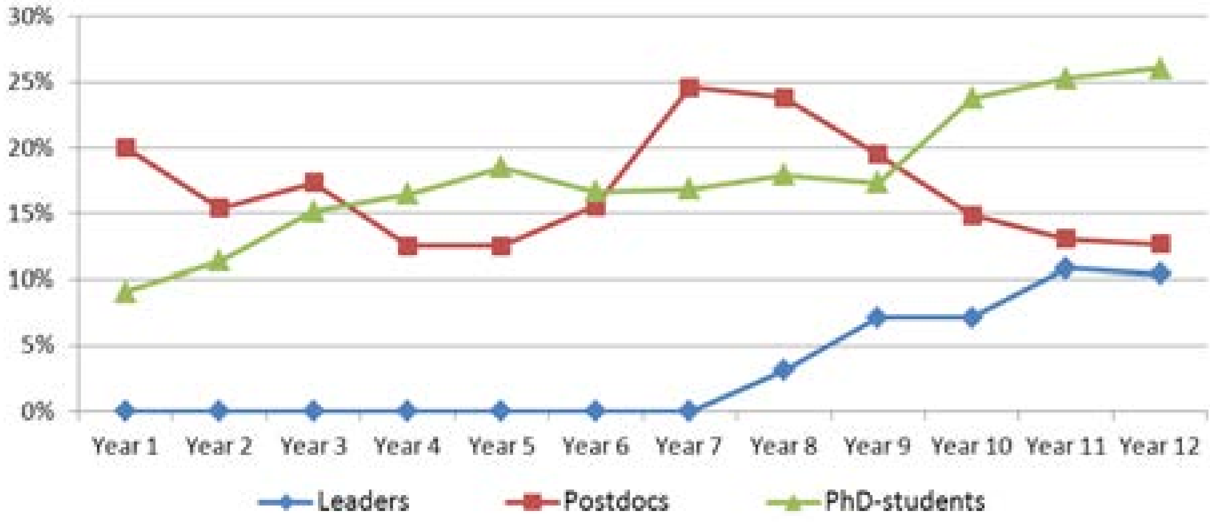

Figure 13: *Proportion of women in years 1 to 12 — NCCR MaNEP data from March 2013/IR 12.*

6.3. Experiences and outlook

The NCCR MaNEP has developed a focused strategy to motivate female high school students to opt for a career in science and possibly in physics. Although the scientific scope for students was limited to materials with novel electronic properties, we hope that the initiatives MaNEP has implemented and validated can be adapted on a larger scale by appropriate organisms. AoW has to be developed at the institutional level to have a real impact on society. It is essential to work with University and Faculty equality offices and commissions. Specific actions launched by MaNEP, in particular the summer internships and exchange programmes, will be continued at an equivalent level by the new Swiss association which shall resume the networking activities deployed by MaNEP.

On a final note, the confidential MaNEP survey conducted during phase III among all the female collaborators did not reveal any negative aspects in terms of their integration and professional relationships with colleagues in a predominantly male workplace. The key challenge is the successful combination of professional and family life, for which institutional help and recognition need to be strongly encouraged. More work flexibility without the negative perceptions of insufficient commitment would be welcome, not only for women researchers but all working parents and care-takers. Finding solutions for women today is anticipating solutions for equal couples tomorrow. We will continue to advocate the importance of these concerns beyond the formal end of the NCCR.

7. Communication

7.1 Strategy, aims and resources

MaNEP deployed distinct communication strategies adapted to the specific needs of each of the three phases. The focus during phases I and II was twofold: firstly, develop the visibility of MaNEP; secondly, establish this NCCR as a new key player in the research on novel electronic materials. The target audiences were mostly industry, media and Home institution press service, the scientific community and academic institutions, but also the political authorities and the general public. A communication officer position was created during phase II to develop new tools, partnerships and alliances to maximise the impact and success of the outreach efforts. During phase III, supporting and maintaining the wide range of activities beyond the end of the SNSF funding period became an important aspect of communication. The communication strategy thus shifted to post-NCCR structural and financial changes of MaNEP, targeting specific groups and individuals identified as important stakeholders for MaNEP's future activities.

Communication was also very important within the MaNEP Network, to promote synergies among the participating scientists, universities, institutes and industries. The preferred communication language to this end was English. Documents addressed to the general public were prepared in French, with some of them released in German. Financial resources allocated to communication increased steadily throughout the twelve years, reflecting not only its professionalisation but also the substantial increase in the number and scale of organised events. Financial and human resources were provided by MaNEP. As the objectives and strategy became more and more ambitious, fund raising was conducted in 2011 to support major communication projects (e.g. SUPRA100, ScienScope). This allowed reinforcing partnerships with existing stakeholders and developing new ones.

7.2 Achievements

A broad range of communication tools were developed to promote MaNEP, the NCCR Network and its research depending on the target audiences. The communication strategy primarily relied on special events, exhibitions, open days, conferences, brochures and flyers, and to a lesser extent on press releases — a complete list is given in Annex 6. Internet was an important communication channel, with a website well visited by Network members and visitors from Switzerland and many countries around the world (primarily USA, France, Germany, and also India). The good ranking of the MaNEP website on internet search engines shows clear national and international interest in the scientific endeavour of MaNEP. The number of views of the website showed a tendency to increase during outreach events organised by the NCCR.

MaNEP published a regular newsletter, starting with a printed issue before switching to an e-newsletter. It produced numerous booklets and flyers to promote its research and special events. To ensure the cohesion of the Network, in addition to internal reports, Forum meetings, newsletters and the website, MaNEP was running a strong and very active programme of topical meetings, conferences and schools. Of order 180 MaNEP members gathered every two years at an international workshop in Les Diablerets to share latest discoveries and hear from international top scientists (see section 5.2).

Three widely distributed movies presenting MaNEP on the occasion of special events were produced in collaboration with outstanding actors, a Swiss humourist, a Nobel Prize laureate and a renowned sculptor. MaNEP was well relayed in the media according to an external report. Research and significant discoveries were promoted through press releases, regular messages to the media and informal contacts, in particular with the RTS (*Radio Télévision Suisse* — French language Swiss broadcasting network), to reach a broad audience.

To address the general public of all ages, MaNEP deployed two distinct strategies: communication was either concentrated on a purely scientific topic or it was built around an artistic initiative taken as an opportunity to talk about science. The first science-focused event took place in 2002, during the MaNEP inauguration open days with political, scientific, and academic authorities. In 2005, MaNEP seized a unique opportunity to participate at the Geneva Student Fair in Palexpo, where the NCCR was the guest star of the UniGE booth. Hundreds of people including school children showed interest. In 2007, MaNEP organised the *Suprafête*, an ambitious public event which attracted 1'500 visitors, to celebrate 20 years of the Nobel Prize awarded to the discovery of high-temperature superconductivity.

MaNEP explored very successfully the use of art as an alternative way of communicating with the general public. The *Suprafête* was a first such experience, with an exhibition on superconductivity (re)viewed by Swiss cartoonist **Mix & Remix** and a leaflet much appreciated by physics teachers. To celebrate 100 years of superconductivity in 2011, MaNEP teamed up with renowned sculptor **Etienne Krähenbühl** who created SUPRA100, a world premier piece of art depicting superconducting levitation. On the same occasion, MaNEP also collaborated with **Exos**, a troupe of jugglers and dancers who created an acrobatic theatre show involving superconductivity. These two artistic events, combined to open house and conferences, drew a total of 14'000 visitors over a period of eight weeks. They were a unique opportunity to explain the scientific background and potential technological impact of superconductivity on society to a very broad audience. The Exos spectacle was presented on two occasions to the UniGE staff, with over 2'000 enthusiastic collaborators applauding the performance during the 2010 spring party. SUPRA100 has become an itinerant exhibition currently displayed until May 20, 2013 at the *Muséum d'Histoire Naturelle* in Neuchâtel. During the first three months, SUPRA100 drew nearly 15'000 visitors to discover superconductivity. These partnerships proved extremely valuable to reach the general public with a scientific topic it would otherwise not be exposed to. Such initiatives shall be pursued in the future, with Barcelona and other places interested in hosting SUPRA100.

Reaching out to the younger generations, MaNEP created the **PhysiScope** in 2007, in collaboration with the Physics Section of UniGE and the support of private foundations. The PhysiScope is a theatre-laboratory proposing a very intuitive and hands-on approach to physics. Open to the public, it is more particularly intended to introduce the younger generations to the excitement of scientific research. Attendance has been steadily increasing since its inauguration in 2008, with nearly 50% female visitors. The total number of visitors has exceeded 16'000, with about 4'500 visitors per year today, a number still increasing. The PhysiScope is a fantastic communication vector. It led MaNEP to collaborate on innovative educational initiatives with CERN, IUFE (*Institut* *universitaire de formation des enseignants*) and the Geneva Department for Public Education (*Dessine-moi un physicien, Dans la peau d'un chercheur*). It is contributing to a programme to establish a remote controlled observatory at the Gornergrat. Most recently, the RTS and the PhysiScope have started producing a series of weekly shows for *L'Oreille des Kids*. A total of thirty 15 minutes shows designed for children 7 – 10 year old are to be produced. The first show was broadcast April 10, 2013, and immediately achieved fantastic audience rates. This collaboration with RTS has developed over the years, with significant outcomes including a series of short interviews featuring MaNEP scientists and demonstrations, all published on the RTS website.

Communication was also instrumental in establishing strategically important partnerships and connections. Ties with CERN have been reinforced with the participation of MaNEP at CERN's 50th anniversary celebrations (2004). In 2008, about 15'000 visitors enjoyed MaNEP demonstrations on superconductivity organised to mark the start of CERN's LHC. The same year, MaNEP presented an interactive exhibition at CERN's Globe, which gathered some 3'000 visitors during three months. To celebrate 100 years of superconductivity in 2011, MaNEP took part in a joint press conference with CERN and UniGE, and the PhysiScope entertained school classes at CERN's Globe.

To ensure the sustainability of the NCCR beyond the period of federal funding, specific steps were taken to reach decision makers and key stakeholders. A strong and strategic relationship was established between MaNEP and the Geneva Economic Promotion. Valued as an important actor, MaNEP was invited by the Canton of Geneva in 2012 and 2013 to share its booth during a big professional trade show at Palexpo. The Geneva Creativity Center, a very active platform linking industry with fundamental and applied research, was initiated by MaNEP in 2010 based on the NCCR's KTT achievements. The inauguration of the PhysiScope in 2008, the celebrations around 100 years of superconductivity in 2011, and several other events and meetings were great opportunities to reach selected stakeholders, like politicians, industrial partners and private foundations.

The reputation of the NCCR MaNEP extends far beyond Switzerland, with a leading position in the field of novel electronic materials. MaNEP has become a trademark, enjoying strong visibility on the national and international scientific scenes. Beyond establishing MaNEP as a key scientific player in Switzerland and abroad, the communication efforts have had an important impact on the perception of science throughout society. MaNEP has become a recognised actor among crucial stakeholders towards the sustainability of its achievements.

7.3 Experiences and outlook

The proactive communication strategy of the NCCR MaNEP, mostly based on special public and stakeholder events, has been extremely effective in reaching a broad audience. Press releases and written communications often do not reach beyond an already interested audience. Events offer best opportunities to explain the challenges of modern research in establishing a direct and often personal dialogue with the audience and public. Art has proven an especially effective communication vector to reaching new audiences normally not interested in science, with surprising results and feedback. However, this approach is more costly and labour intensive, and has a significant impact on the management expenses incurred by the NCCR MaNEP. Another valuable consequence of this strategy is the strengthening of the community through participating in organising and running the many MaNEP events.

While MaNEP is present on YouTube and LinkedIn, its visibility on social networks could have been strengthened for better international visibility, especially with the non-scientific public. This recommendation by an external consultant shall be considered when promoting the structures succeeding MaNEP. A further recommendation was to develop a business intelligence based on competition, technological innovations and e-reputation, to evaluate more closely the impact of actions and to help making strategic decisions. Stabilising the fantastic growth in physics in the area of MaNEP in Geneva triggered by the NCCR will require maintaining the communication effort. MaNEP has been actively contributing to many events organised by UniGE. The strong partnerships established with UniGE communication services and chancellor's office on those instances will be extremely valuable in this effort. A communication strategy is being prepared to inform about the future structures sustaining MaNEP's achievements and projecting it in the long run.

8. Conclusions of the NCCR-Director

The NCCR has been a fantastic funding scheme to promote and federate research in novel electronic materials. It played a central role in strengthening the Swiss condensed matter community over the last twelve years. Significant progress has been achieved on all fronts, from a fundamental understanding of intrinsic physical mechanisms to a more practical level of new materials synthesis and applications. The Network has led to a common and in many ways coordinated approach to various problems of relevance to the quest of novel and technologically interesting materials. On the international scene, MaNEP has established a strong reputation with recognised research and contributions to many unresolved hot topics. These outstanding accomplishments are the fruits of the commitment of scientists, a very effective administrative support and insightful guidance and advice provided by the review panel and the external advisory board — many thanks to all of them.

The core area of interest to MaNEP is continuously evolving and often rapidly changing. Fascinating new materials (graphene, pnictides), processes (atomic-scale material synthesis) and physical concepts (topological insulators) were discovered and developed during the past twelve years. The NCCR scheme has given Switzerland the means and flexibility to adapt rapidly and make significant contributions to these emerging topics. The Network of scientific competences assembled during MaNEP will continue to strive for the same efficiency, albeit without dedicated support, which is regrettable.

MaNEP has also had a very positive impact on a local scale, at the Home institution. The flexibility of the allocated NCCR funds has been a fantastic asset, enabling to respond very swiftly to new challenges. Competitive start-up packages enabled to attract professors to expand and strengthen the field of condensed matter physics in Switzerland. The national and international standings, confirmed by independent international assessments, gave MaNEP a very strong position to develop and consolidate activities in its field of expertise at the Home institution. A very concrete result is a remarkable bolstering of condensed matter physics in Geneva at a time of financial restrictions. The NCCR has had far reaching and lasting benefits beyond the core topic of MaNEP, with significant additional support by the Home institution for the entire Physics Section, for astronomy and for mathematics.

Note: Prof. Øystein Fischer, initiator and director of the NCCR MaNEP, suffered a severe stroke on February 1st, 2013. The above concluding remarks have been compiled by Prof. Christoph Renner, deputy director since 2007 and interim director since February 18, 2013. They summarise his own views and those of Øystein Fischer based on discussions prior to his stroke and notes he left.

Geneva, May 2013

Annex 1: List of most important publications of the NCCR

Condensing twelve years of research with more than 3'100 publications into 25 selected articles has been a daunting task. The following 25 publications have been selected to constitute a fair and balanced representation of the scientific research conducted in MaNEP. Selection guidelines were scientific impact, collaborative aspects and representativeness of the participating groups and institutes. The outcome of this exercise is listed below in no particular order.

N. Reyren, S. Thiel, A. D. Caviglia, L. Fitting Kourkoutis, G. Hammerl, C. Richter, C. W. Schneider, T. Kopp, A.-S. Rüetschi, D. Jaccard, M. Gabay, D. A. Muller, J.-M. Triscone, and J. Mannhart,
Superconducting interfaces between insulating oxides
Science **317**, 1196 (2007)

Ch. Rüegg, N. Cavadini, A. Furrer, H.-U. Güdel, K. Krämer, H. Mutka, A. Wildes, K. Habicht, and P. Vorderwisch
Bose-Einstein condensation of the triplet states in the magnetic insulator $TlCuCl_3$
Nature **423**, 62 (2003)

A. B. Kuzmenko, E. van Heumen, F. Carbone, and D. van der Marel
Universal optical conductance of graphite
Physical Review Letters **100**, 117401 (2008)

C. R. Ast, J. Henk, A. Ernst, L. Moreschini, M. C. Falub, D. Pacilé, P. Bruno, K. Kern, and M. Grioni
Giant spin splitting through surface alloying
Physical Review Letters **98**, 186807 (2007)

M. Guarise, B. Dalla Piazza, M. Moretti Sala, G. Ghiringhelli, L. Braicovich, H. Berger, J. N. Hancock, D. van der Marel, T. Schmitt, V. N. Strocov, L. J. P. Ament, J. van den Brink, P.-H. Lin, P. Xu, H. M. Rønnow, and M. Grioni
Measurement of magnetic excitations in the two-dimensional antiferromagnetic $Sr_2CuO_2Cl_2$ insulator using resonant X-ray scattering: evidence for extended interactions
Physical Review Letters **105**, 157006 (2010)

M. Kenzelmann, Th. Strässle, C. Niedermayer, M. Sigrist, B. Padmanabhan, M. Zolliker, A. D. Bianchi, R. Movshovich, E. D. Bauer, J. L. Sarrao, and J. D. Thompson
Coupled superconducting and magnetic order in $CeCoIn_5$
Science **321**, 1652 (2008)

H. P. Büchler and G. Blatter
Supersolid versus phase separation in atomic Bose-Fermi mixtures
Physical Review Letters **91**, 130404 (2003)

H. Cercellier, C. Monney, F. Clerc, C. Battaglia, L. Despont, M. G. Garnier, H. Beck, P. Aebi, L. Patthey, H. Berger, and L. Forró

Evidence for an excitonic insulator phase in 1T-$TiSe_2$

Physical Review Letters **99**, 146403 (2007).

B. Sacépé, J. B. Oostinga, J. Li, A. Ubaldini, N. J. G. Couto, E. Giannini, and A. F. Morpurgo

Gate-tuned normal and superconducting transport at the surface of a topological insulator

Nature Communications **2**, 575 (2011)

P. A. Frigeri, D. F. Agterberg, A. Koga, and M. Sigrist

Superconductivity without inversion symmetry: MnSi versus $CePt_3Si$

Physical Review Letters **92**, 097001 (2004)

Ph. Werner, A. Comanac, L. de' Medici, M. Troyer, and A. J. Millis

Continuous-time solver for quantum impurity models

Physical Review Letters **97**, 076405 (2006)

M. S. A. Hossain, C. Senatore, R. Flükiger, M. A. Rindfleisch, M. J. Tomsic, J. H. Kim, and S. X. Dou

The enhanced J_c and B_{irr} of in situ *MgB_2 wires and tapes alloyed with $C_4H_6O_5$ (malic acid) after cold high pressure densification*

Superconductor Science and Technology **22**, 095004 (2009)

K. Kodama, M. Takigawa, M. Horvatić, C. Berthier, H. Kageyama, Y. Ueda, S. Miyahara, F. Becca, and F. Mila

Magnetic superstructure in the two-dimensional quantum antiferromagnet $SrCu_2(BO_3)_2$

Science **298**, 395 (2002)

V. Scagnoli, U. Staub, Y. Bodenthin, R. A. de Souza, M. García-Fernández, M. Garganourakis, A. T. Boothroyd, D. Prabhakaran, and S. W. Lovesey

Observation of orbital currents in CuO

Science **332**, 696 (2011)

K.-Y. Yang, T. M. Rice, and F.-C. Zhang

Phenomenological theory of the pseudogap state

Physical Review B **73**, 174501 (2006).

M. L. Reinle-Schmitt, C. Cancellieri, D. Li, D. Fontaine, M. Medarde, E. Pomjakushina, C. W. Schneider, S. Gariglio, Ph. Ghosez, J.-M. Triscone, and P. R. Willmott

Tunable conductivity threshold at polar oxide interfaces

Nature Communications **3**, 932 (2012)

D. SCHMIDIGER, P. BOUILLOT, S. MÜHLBAUER, S. GVASALIYA, C. KOLLATH, T. GIAMARCHI, AND A. ZHELUDEV

Spectral and thermodynamic properties of a strong-leg quantum spin ladder

Physical Review Letters **108**, 167201 (2012)

P. SAMUELSSON, E. V. SUKHORUKOV, AND M. BÜTTIKER

Orbital entanglement and violation of Bell inequalities in mesoscopic conductors

Physical Review Letters **91**, 157002 (2003)

Ø. FISCHER, M. KUGLER, I. MAGGIO-APRILE, CH. BERTHOD, AND CH. RENNER

Scanning tunneling spectroscopy of high-temperature superconductors

Reviews of Modern Physics **79**, 353 (2007)

P. PARUCH, T. GIAMARCHI, AND J.-M. TRISCONE

Domain wall roughness in epitaxial ferroelectric $PbZr_{0.2}Ti_{0.8}O_3$ *thin films*

Physical Review Letters **94**, 197601 (2005)

A. V. SOLOGUBENKO, H. R. OTT, G. DHALENNE, AND A. REVCOLEVSCHI

Universal behavior of spin-mediated energy transport in S = 1/2 chain cuprates: $BaCu_2Si_2O_7$ *as an example*

Europhysics Letters **62**, 540 (2003)

A. DUSZA, A. LUCARELLI, F. PFUNER, J.-H. CHU, I. R. FISHER, AND L. DEGIORGI

Anisotropic charge dynamics in detwinned $Ba(Fe_{1-x}Co_x)_2As_2$

Europhysics Letters **93**, 37002 (2011)

J.-P. BRANTUT, J. MEINEKE, D. STADLER, S. KRINNER, AND T. ESSLINGER

Conduction of ultracold fermions through a mesoscopic channel

Science **337**, 1069 (2012)

M. ANGST, R. PUZNIAK, A. WISNIEWSKI, J. JUN, S. M. KAZAKOV, J. KARPINSKI, J. ROOS, AND H. KELLER

Temperature and field dependence of the anisotropy of MgB_2

Physical Review Letters **88**, 167004 (2002)

A. J. DREW, J. HOPPLER, L. SCHULZ, F. L. PRATT, P. DESAI, P. SHAKYA, T. KREOUZIS, W. P. GILLIN, A. SUTER, N. A. MORLEY, V. K. MALIK, A. DUBROKA, K. W. KIM, H. BOUYANFIF, F. BOURQUI, C. BERNHARD, R. SCHEUERMANN, G. J. NIEUWENHUYS, T. PROKSCHA, AND E. MORENZONI

Direct measurement of the electronic spin diffusion length in a fully functional organic spin valve by low-energy muon spin rotation

Nature Materials **8**, 109 (2009)

Annex 2: Cooperation with parties outside the NCCR

Category of cooperations with parties outside the NCCR (all three periods)

Category	Number
Programmes:	***35***
Framework FP - EU	14
Cost	1
Other	20
Research Institutions:	***253***
Swiss	28
Europe	157
North America	42
Asia	15
Other	11
Economy / Industry:	***37***
Swiss	33
Other	4
Other:	***4***
Public sector	1
Foundations	3
Other	0
Total	**329**

Category and type of cooperations with parties outside the NCCR (all three periods)

Category	Number of cooperations	Exchange of knowledge	Exchange of technology	Exchange of data	Exchange of staff	Joint projects	Contracts
Programmes	35	27	6	16	11	5	18
Research Institutions	253	196	25	154	35	38	12
Economy / Industry	37	32	21	21	4	25	15
Other	4	0	0	0	0	4	1
Total	**329**	**255**	**52**	**191**	**50**	**72**	**46**

Annex 3: List of cooperating companies and universities of applied sciences (all three periods)

Small companies (up to 250 employees)

Name	Place	Country
Sécheron SA	Meyrin, Genève	Switzerland
MecSens SA	Carouge, Genève	Switzerland
METROLAB Instruments SA	Genève	Switzerland
SwissNeutronics	Klingnau	Switzerland
Kugler Bimetal SA	Le Lignon, Genève	Switzerland
Manufacture d'Outils Dumont SA	Montignez	Switzerland
Dynamic Motion SA	La Chaux de Fonds	Switzerland
Phasis Sàrl	Genève	Switzerland
Sensorscope Sàrl	Lausanne	Switzerland
Boost Consulting Inc.	Somerville	United States of America
Ereo SAS	Saint-Genis	France
Institut Technologies du vivant	Sion	Switzerland
NIRVA Industries SA	Genève	Switzerland
TIMELAB	Genève	Switzerland
Techgraving SA	Lausanne	Switzerland
SPECS	Berlin	Germany
Omicron Nanotechnology	Taunusstein	Germany
Winterthur Instruments GmbH	Winterthur	Switzerland

Total: 18

Large companies

Name	Place	Country
IBM Research Laboratory GmbH	Rüschlikon	Switzerland
Toyota Research & Development	Nagoya	Japan
Rolex SA	Plan-les-Ouates, Genève	Switzerland
Vacheron Constantin SA	Genève	Switzerland
Microsoft Research	Santa Barbara	United States of America
Bruker BioSpin	Fällenden, Zürich	Switzerland
Asulab The Swatch Group R&D Ltd.	Marin	Switzerland
GF AgieCharmilles	Meyrin, Genève	Switzerland
ABB Switzerland Ltd Corporate Research	Baden	Switzerland
Caran d’Ache	Genève	Switzerland

Total: 10

Universities of applied sciences

Name	Place	Country
HES-SO hepia	Genève	Switzerland

Total: 1

Annex 4: List of CTI projects

CTI projects	Research partner	Industry partner	Total funding (CHF)	CTI funding (CHF)	Self-funding Industry partner (CHF)
Faisabilité d'un dépôt de couches minces d'or ultraplates pour les marches de la recherche dans les nanosciences	Université de Genève	Feasibility project	184'284	90'104	94'180
Hydrogen detectors and sensors for PEM fuel cell combustion systems	Klaus Yvon Université de Genève	Joachim Grupp ASULAB - SWATCH Group	1'084'615	480'000	604'615
Faisabilité d'une technique de marquage pour l'authentification d'objets métal-liques	Øystein Fischer, Jorge Cors, Université de Genève	Feasibility project	80'176	80'176	—
Nouveaux traitements de surface pour moules à injection fabriqués par éléctro-érosion	University of Geneva	GF AgieCharmilles SA	416'688	416'688	—
Marquage microscopique de compo-sants horlogers	Jorge Cors Université de Genève	Alexandre Chiriotti Vacheron Constantin SA	760'000	360'000	400'000
Lead-free antifriction copper alloys de-posited on steel by surface coating tech-niques	University of Geneva	Kugler Bimetal	549'192	305'937	243'255
Nb_3Sn strands with enhanced properties at high field for economically viable 1 GHz magnetic resonance magnets	René-Louis Flükiger, Øystein Fischer Université de Genève	Bruker BioSpin AG Fällanden	2'020'092	594'002	1'426'090
Kohlenstoff-Nanoröhrchen Kaltkathoden für Miniatur-Röntgenröhren	Oliver Gröning Empa Thun	Comet AG, Flamatt	721'110	361'350	359'760
Total: 8 Projects			**5'816'157**	**2'688'257**	**3'127'900**

Annex 5: Start-up Companies

Name of company:	Phasis
Place(s):	Geneva, Switzerland
Legal form:	Limited Liability Company (LLC)
Founding year:	2004
In Operation (yes/no):	yes
Liquidated (yes/no):	no
Financing: Private (own, family, friend capital) (yes/no):	Private
Venture capital (yes/no):	no
Number of current workforce:	2
Number of products on the market:	2 lines of products
Number of products in the pipeline:	1
Industry sector:	Laboratory supplies
Name of contact person in the company:	Dr Jorge Cors
Website:	www.phasis.ch

Contacts to the NCCR: Name(s) of research groups that have collaborated, sort of collaboration (founding, technology transfer, patents, licences, employment of young researchers coming from the NCCR, etc.)

The company has collaborated with the group of Prof. Øystein Fischer, in particular the technology transfer of STM technology and know-how. R&D was also done through CTI projects.

The company has obtained the licence to exploit academic patents through the Technology Transfer Office UNITEC from the University of Geneva.

Annex 6: Outputs communications

Communications outputs (data from April 2013)

Form of output	Number (Total)	Periodicity*	Remarks
Newsletters (paper)	7	about 2 per year	from 2001 to 2004.
E-Newsletters	27	from 2 to 7 per year	from 2005 to 2013.
Portraits / Brochures	15		This number includes MaNEP portraits brochures; exhibition's catalogues, leaflet and programmes; three films produced by MaNEP; exhibitions.
Website / number of re-launches	3		
Press Releases	20		
Media events / press conferences	7		
Other forms of knowledge transfer (e.g. interviews in mass media)	424		
Articles in newspapers and magazines	*201*		
Radio and TV programmes	*57*		
Web	*86*		
Public talks	*46*		
Other forms of public relations	*34*		
Other forms of technology transfer	45		It includes booths at fairs like Hannover Messe, EPHJ-EPMT-STM tradeshow, Nanofair and Nano-tech, talks, visits of industries, transfer projects, workshops and seminars. MaNEP was also the initiator of the Geneva Creativity Center.
PhysiScope			More than 16'000 visitors until present, about 4'500 visitors per year.
External events (general public, schools, stakeholders)	66		Main events: • MaNEP inauguration ceremony and open days labs – 2002. • Participation in the *Nuit de la Science* Geneva – 2004 – 2010 – 2012. • Participation in CERN 50th birthday with MaNEP demonstrations – 2004. • Geneva Student Fair – 2005. • *Suprafête* with many events — 2007. • Official launch of the PhysiScope with Geneva's authorities – 2008. • Partnership with CERN for its open doors and for an interactive exhibition at the Globe – 2008. • 450th anniversary of UniGE with demonstrations and booth – 2009. • Celebration of 100th anniversary of discovery of superconductivity – 2011. • SUPRA100 travelling exhibition at the Muséum of Neuchâtel – 2013.
Events for internal communications	40		These events include topical meetings, workshops and conferences, as well as an artistic show.

*Periodicity = optional, can substitute or complement number.

Source NIRA/IR 1 - 12: Other forms of output – Other forms of knowledge transfer, report 4470 and Other forms of technology transfer, report 4475

Annex 7: MaNEP Forum members (full and associate) over the three phases

Markus Abplanalp, ABB (2003 →)
Philipp Aebi, UniNE & UniFR
Dionys Baeriswyl, UniFR
Bertram Batlogg, ETHZ (2009 →)
Felix Baumberger, UniGE & PSI (2012 →)
Hans Beck, UniNE (→ 2005)
Christian Bernhard, UniFR (2006 →)
Christophe Berthod, UniGE (2009 →)
Gianni Blatter, ETHZ
Harald Brune, EPFL (2009 →)
Philippe Buffat, EPFL (→ 2005)
Markus Büttiker, UniGE
Radovan Černý, UniGE (2011 →)
Kazimierz Conder, PSI (2009 →)
Jorge Cors, UniGE & Phasis (2009 →)
Michel Decroux, UniGE (2009 →)
Leonardo Degiorgi, ETHZ (2004 →)
Bernard Delley, PSI (2009 →)
Bertrand Dutoit, EPFL (2009 →)
Daniel Eckert, Bruker BioSpin
Tilman Esslinger, ETHZ (2009 →)
Manfred Fiebig, ETHZ (2012 →)
Øystein Fischer, UniGE — director
René Flükiger, UniGE
László Forró, EPFL
Albert Furrer, ETHZ & PSI (→ 2005)
Antoine Georges, UniGE (2011 →)
Thierry Giamarchi, UniGE (2003 →)
Enrico Giannini, UniGE (2009 →)
Marco Grioni, EPFL (2004 →)
Vladimir Gritsev, UniFR (2009 →)
Martin Hasler (→ 2005)
Hans-Joseph Hug, Empa (2009 →)
Jürg Hulliger, UniBE (2004 →)
Didier Jaccard, UniGE (2009 →)
Alain Junod, UniGE (→ 2005)
Janusz Karpinski, ETHZ (2004 →)
Hugo Keller, UniZH
Michel Kenzelmann, PSI (2009 →)
Corinna Kollath, UniGE (2011 →)
Ivan Maggio-Aprile, UniGE (2009 →)
Dirk van der Marel, UniGE (2004 →), deputy director (2007 →)
Giorgio Margaritondo, EPFL (→ 2009)
Piero Martinoli, UniNE (→ 2006)
Joël Mesot, PSI, ETHZ, & EPFL (2004 →)
Frédéric Mila, UniL & EPFL
Elvezio Morenzoni, PSI (2006 →)
Alberto Morpurgo, UniGE (2008 →)
Reinhard Nesper, ETHZ
Christof Niedermayer, PSI (2009 →)
Frithjof Nolting, PSI (2009 →)
Hans-Rudolf Ott, ETHZ
Patrycja Paruch, UniGE (2007 →)
Greta Patzke, UniZH (2009 →)
Willi Paul, ABB (→ 2003)
Davor Pavuna, EPFL (2009 →)
Christoph Renner, UniGE (2007 →), deputy director (2007 →), interim director (2013)
T. Maurice Rice, ETHZ
Nico de Rooij, EPFL (2009 →)
Henrik M. Rønnow, EPFL (2009 →)
Christian Rüegg, PSI & UniGE (2011 →)
Andreas Schilling, UniZH (2003 →)
Louis Schlapbach, UniFR & Empa
Carmine Senatore, UniGE (2011→)
Maria J. W. Seo, EPFL (2004 → 2007)
Manfred Sigrist, ETHZ
Nicola Spaldin, ETHZ (2012 →)
Urs Staub, PSI (2009 →)
Gilles Triscone, Hepia (2009 →)
Jean-Marc Triscone, UniGE deputy director (2001 → 2007)
Matthias Troyer, ETHZ (2004 →)
Anke Weidenkaff, Empa & UniBE (2009 →)
Philipp Werner, UniFR (2009 →)
Philip Willmott, PSI & UniZH (2009 →)
Klaus Yvon, UniGE (2008 →)
Oksana Zaharko, PSI (2009 →)
Andrey Zheludev, ETHZ (2009 →)

Annex 8: Members of the advisory board (phases II and III)

Dave Blank, University of Twente, Enschede, Netherlands

Robert J. Cava, Princeton University, USA

Antoine Georges, Ecole Polytechnique, Palaiseau, France (→ 2011)

Denis Jérôme, Université Paris-Sud, Orsay, France

Piero Martinoli, Università della Svizzera Italiana, Lugano, Switzerland (→ 2009)

Andrew Millis, Columbia University, New-York, USA

George Sawatzky, University of British Columbia, Vancouver, Canada