SEVENTH FRAMEWORK PROGRAMME
CAPACITIES
Specific Programme Research Infrastructures

Grant agreement for: Integrating Activity-Combination of Collaborative Project and Coordination and Support Action for Integrating Activities

Annex I - "Description of Work"

Project acronym: *EuroMagNETII*

Project full title: *A coordinated approach to access, experimental development and scientific exploitation of all European large infrastructures for high magnetic fields*

Grant agreement no.: *228043-EuroMagNETII-Integrating Activities*

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CONTENT

PART A

A.1 Project summary

(Copy of the A1 form of the GPF)

GENERAL INFORMATION			
Project title 3	A coordinated approach to access, experimental development and scientific exploitation of all European large infrastructures for high magnetic fields		
Starting date 4	01/01/2009		
Duration in months 5	48		
Call (part) identifier 6	FP7-INFRASTRUCTURES-2008-1		
Activity code(s) most relevant to your topic 7	INFRA-2008-1.1.1: Bottom-up approach: Integrating Activities in all scientific and technological fields	INFRA-2008-1.1.1: Bottom-up approach: Integrating Activities in all scientific and technological fields	
Free keywords 8		high magnetic fields	
Abstract 9 (max. 2000 char.)			

Research infrastructures are part of the EC's current priorities in structuring the European research area. Among these, the importance of high magnetic field facilities has been recognized, as witnessed by the continued EC funding of many high magnetic field projects. Under FP6, three different projects have been accepted. The Grenoble High Magnetic Field Laboratory ihas been running a RITA program (until 31/12/2007), whereas the TNA of all other European high field facilities is being coordinated by the I3 'EuroMagNET' (until 31/12/2008). The European pulsed high magnetic field laboratories are executing a Design Study for the next generation pulsed field user facilities (until 31/3/2009). All these programs are running very satisfactorily and contribute to the excellence of Europe's high magnetic field research. For FP7, the principal actors of Europe's high magnetic field research, the Grenoble High Magnetic Field Laboratory (Grenoble, France), the High Field Magnet Laboratory (Nijmegen, the Netherlands), the Hochfeld Labor Dresden (Dresden, Germany) and the Laboratoire National des Champs Magnétiques Pulsés (Toulouse, France) propose to unite all their transnational access, together with joint research activities and networking activities into one I3, called 'EuroMagNET II'. This I3 is considered as a very important step towards full collaboration between Europe's high field facilities, which will bring European high magnetic field science to a comparable level of that in the USA. It is also a step towards the creation of a multi-site European Magnetic Field Laboratory (EMFL). Within the context of the ESFRI Roadmap Update, a proposal for such an EMFL is currently under consideration, for a planned realization in 2015.

A.2 List of Beneficiaries

Beneficiary Number	Beneficiary name	Beneficiary short name	Country	Date enter project	Date exit project
1(coordinator)	Centre National de Recherche Scientifique	CNRS	France	M1	M48
2	Radboud University Nijmegen	RU	The Netherlands	M1	M48
3	Forschungszentrum Dresden -Rossendorf	FZD	Germany	M1	M48
4	University of Leipzig	ULEI	Germany	M1	M48
5	University of Oxford	UOX-DK	UK	M1	M48
6	Tallinn University of Technology	TUT	Estonia	M1	M48
7	Weizmann Institute	WI	Israel	M1	M48

A.3 Overall budget breakdown for the project

(copy of A3.2 form of the GPF).

Participant number in this project [9]	Participant short name	Estimated eligible costs (whole duration of the project)						Total receipts	Requested EC contribution
		RTD (A)	Coordination (B)	Support (C)	Management (D)	Other (E)	Total A+B+C+D+E		
1	CNRS	1,878,179.20	192,000.00	3,126,400.00	340,000.00	0.00	5,536,579.20	0.00	4,108,400.00
2	RU	1,539,675.00	96,815.00	1,253,775.00	62,295.00	0.00	2,952,560.00	0.00	1,776,300.00
3	FZD	887,760.00	611,100.00	381,320.00	0.00	0.00	1,880,180.00	0.00	1,295,100.00
4	ULEI	163,200.00	0.00	0.00	0.00	0.00	163,200.00	0.00	78,000.00
5	UOX-DK	272,472.00	96,000.00	0.00	0.00	0.00	368,472.00	0.00	162,200.00
6	TUT	107,200.00	0.00	0.00	0.00	0.00	107,200.00	0.00	40,000.00
7	Weizmann	53,333.34	0.00	0.00	0.00	0.00	53,333.34	0.00	40,000.00
TOTAL		4,901,819.54	995,915.00	4,761,495.00	402,295.00	0.00	11,061,524.54	0.00	7,500,000.00

PART B

B.1 Concept and objectives, progress beyond state-of-the-art, S/T methodology and work plan

B.1.1 Concept and project objectives

A magnetic field is a very powerful thermodynamic parameter to influence the state of any material system. Consequently magnetic fields serve as an experimental tool in very diverse research areas like condensed matter physics, molecular physics, chemistry and, with increasing importance, in biology. The versatility and universality of magnetic fields as a research tool lies in their coupling to the charge and spin of the particles that constitute the matter that surrounds us. Many magnetic field based research techniques are standard and can be done with conventional commercially available magnets and associated equipment (MRI-scanners, NMR and ESR spectrometers, conventional superconducting magnets, etc.). On the other hand there are many cases where very high magnetic fields, only available in a few specialized facilities, are essential and where the prospect of new discoveries is often the greatest. This scientific motivation has always formed a strong drive to develop techniques and installations to generate the highest possible magnetic fields and to perform experiments with them. In recent surveys, both by the European Science Foundation (ESF, "The Scientific Case for a European Laboratory for 100T Science", 1998) and by the USA National Research Council ("Opportunities in High Magnetic Field Sciences", COHMAG 2005), a compelling case has been made for high magnetic fields as a research tool for a wide variety of research topics and strong recommendations were made to stimulate high magnetic field infrastructures.

Since then, the recent developments in high magnetic field science have only underlined the importance and impact of high magnetic fields; to mention only a few of the most remarkable and exciting high field results:

- the observation of a Fermi surface and an electron-like Hall effect in underdoped high T_c superconductors (Doiron-Leyraud et al, Nature **447**, 565 (2007) and Leboeuf et al, Nature **450**, 533 (2007))
- the Quantum Hall effect in graphene (Novosolov et al, Nature **438**, 197 (2005), Zhang et al, Nature **438**, 201 (2005)), even up to room temperature (Novoselov et al, Science Express, 15 February 2007)
- electron fractionalisation in bismuth (K. Behnia et al, Science **317**, 1729 (2007))
- new quantum critical points (Sebastian et al, Nature **441**, 617 (2006))
- magnetic field induced superconductivity in URhGe (Levy et al, Science **309**, 1343 (2005)
- optical signatures of the Aharonov-Bohm effect in carbon nanotubes (Zaric et al, Science **304**, 1129 (2004)).

All these results and many more, obtained at high field infrastructures in Europe or the USA, could not have been obtained without the high magnetic fields and the corresponding sophisticated instrumentation available in such infrastructures. They clearly illustrate the power, versatility and necessity of high magnetic fields as a research tool.

The generation of such high magnetic fields is a technological challenge and their exploitation requires a high financial commitment. Therefore only a few infrastructures exist where very high magnetic fields can be generated and used for research. Large infrastructures for generating continuous magnetic fields in excess of 30 T, powered with 15+ MW power supplies, can be found in the USA (Tallahassee), Japan (Tsukuba) and Europe (Grenoble and Nijmegen). Large pulsed field installations based either on motor generators or large (> 5 MJ) capacitor banks are found in Los Alamos (USA), Tokyo (Japan), and in Europe in Toulouse and in Dresden. Over the last twenty years, financial limitations and the complexity of such installations have resulted in a concentration of these activities in less but larger infrastructures, very often operated on a national scale. E.g. in

2007, the Chinese government has created a national high magnetic field facility, consisting of a static field installation at Heifei and a pulsed field installation in Wuhan. The clearest example of this trend is the creation of the National High Magnetic Field Laboratory in the USA, a three site organization that pioneers all aspects of high magnetic field generation, and its use for scientific experiments. In Europe, for historical and political reasons, the high magnetic field landscape was much more finely distributed and therefore less effective and visible.

A first major step towards improving Europe's collective position in high magnetic field science was the funding under FP6 of the EuroMagNET I3, which united most of the European high field facilities, with a common transnational access programme, networking and joint research activities. This I3 was recently very positively evaluated at its midterm. The Grenoble High Magnetic Field Laboratory (GHMFL), Europe's single largest high field infrastructure, was not yet an integral beneficiary of that I3 but is a full partner in the present project. Therefore this project is a bottom up initiative that *unites all European high magnetic field large infrastructures*, and constitutes a decisive step in putting Europe in the front line of high magnetic field science. It also represents an important step towards a single distributed European laboratory for high magnetic fields, which would bring Europe to par with the USA in this domain. A formal proposal for such a laboratory in the context of the ESFRI Roadmap Upgrade has recently been made by the large infrastructures participating in this proposal and is under consideration. The ESFRI proposal envisages a far reaching integration of the infrastructures, which, coupled with major investments in their installations, will create a European equivalent of the NHMFL. The timescale for the ESRFI initiative is 2015, far beyond the timescale of this EuroMagNETII I3 project.

The *main objectives* of the EuroMagNET II integrated infrastructure initiative are

(1) to stimulate and to coordinate the transnational access to all European large infrastructures for high magnetic fields in order to optimally use the capacity and optimally satisfy the users' needs.

(2) to structure and expand the high field user community by stimulating the exchange of information between high field user groups, the high field facilities and other potentially interested scientific communities. This will be implemented by thematic networks, training and secondments.

(3) to develop new and advanced experimental possibilities as well as improved magnet performance at these infrastructures by joint research activities involving facilities and user groups. These activities will improve the quality of existing instrumentation and will create unique instrumental possibilities, to better serve the existing users and to further attract new users. Three joint research activities (JRA) are foreseen:

High Field User Magnet Technology and Operation

The central tools of all high field science are the magnets and their power supplies. The focus of this JRA is to jointly enhance the performance, reliability, and ergonomics of the technical installations in the European high field facilities for the benefit of the user community.

Nano object measurements and local spectroscopy

An important trend in modern science is the investigation of smaller and smaller structures with properties determined by a nano-sized group of atoms or molecules. Examples are semiconductor quantum dots, organic nanostructures and carbon-based systems like nanotubes and graphene. To unravel their electrical, optical and magnetic properties it is crucial to measure the response of individual nanostructures. The objective of this JRA is to develop new experimental techniques, adapted to the very heavy spatial and temporal constraints of high field magnets, to determine the properties of individual nanostructures and to perform local spectroscopy.

Enhanced Sensitivity and Single Scan NMR (ES^3-NMR)

The aim of this JRA is to jointly develop the necessary instrumentation for cost-efficient NMR experiments in ultra-high magnetic fields and to make it available to the high field user community. The focus of this JRA is the enhancement of the NMR sensitivity, to compensate for the high cost of resistive DC magnetic fields and the limited duty cycles of pulsed magnetic fields.

B.1.2 Progress beyond the state-of-the-art

Europe has currently four mid-scale laboratories that have the necessary installations, knowledge and manpower to operate high level resistive static and pulsed magnets; the Grenoble High Magnetic Field Laboratory (GHMFL) in Grenoble, the Laboratoire National des Champs Magnétiques Pulsés (LNCMP) in Toulouse (both operated by the Centre National de la Recherche Scientifique (CNRS)), the Hochfeld-Magnetlabor Dresden (HLD, Forschungszentrum Dresden-Rossendorf (FZD)) and the High Field Magnet Laboratory (HFML) of the Radboud University (RU) in Nijmegen. All these laboratories are involved both in science (in house research and as user facility) and magnet technology. In Japan, the situation is similar, with five mid-scale installations all over the country although there these installations put more emphasis on materials research and less on general user operation.
The state of the art in high magnetic field science and technology is set by the United States' National High Magnetic Field Laboratory (NHMFL) which is distributed over three sites (Tallahassee, Gainesville and Los Alamos). This national facility largely surpasses the manpower and budget of Europe's four high field facilities put together. The Tallahassee facility has a 48 MW power converter, plus the corresponding water cooling capacity, which is the largest world wide. With this installation, it can generate up to 45 Tesla with a hybrid magnet, which is the actual world record. In comparison, the major European DC magnetic field facilities, GHMFL and HFML have a 24 MW and a 20 MW power converter respectively, and can generate up to 34 Tesla. A similar picture emerges from the comparison of the pulsed magnetic field facilities; the Los Alamos facility has a 1.4 GJ motor generator, and can generate up to 89 Tesla in non-destructive mode. The major European pulsed field facilities, HLD and LNCMP have 50 MJ and 14 MJ respectively, and generate currently up to 75 T and 78 T respectively. The table below gives a comparison between the size and the performance of the NHMFL and the four large European high field infrastructures;

Table 1.1

	NHMFL	GHMFL	HFML	HLD	LNCMP	Σ Europe
Power (static) MW **Energy (pulsed) MJ**	48 5 + 600	24 -	20 -	- 50	- 14	
Max field static **Max field pulsed**	45 89	34 -	34 -	- 75	- 78	
Total investment M€	161	33	35	28	7	80
Annual budget M€	36	5,6	3,8	3,5	2,9	16
Permanent staff	212	53	14	13	34	114
Publications/year	395	110	28	29	60	224
Publication/y/M€	11					14

Aware that only a joint, coordinated effort can bring Europe's high magnetic field science to par with that of the USA, since several years, the European high field laboratories have intensified their collaboration as much as possible, e.g. within the framework of two FP6 programs (I3-EuroMagNET and DS-DeNUF). This collaboration has made that the European performance in this area of science is very good, despite the much lower funding compared to the US. The EuroMagNETII I3 integrates the European high field facilities even more strongly than the preceding high field I3 EuroMagNET; The GHMFL is now a full partner of the consortium, and the new HLD facility has also been integrated. EuroMagNETII should be seen as an important step towards extensive integration of all the European high field infrastructures which will be further pursued in the ESRFI context, the ultimate aim being to provide European researchers with the same possibilities in high field research as have their American colleagues, in the form of a delocalized European Magnetic Field Laboratory. Part of the performance of EuroMagNETII should therefore be measured by the progress towards this goal. Other performance indicators will be the increase of the user community and the number of publications resulting from EuroMagNETII.

An important ingredient in the present project is that the exchange of information between the facilities and between the user community will be greatly enhanced. This exchange will lead to better magnets, more economical operation of the installation, more advanced experimental techniques, better service to users, in short; a much better performing high field research operation in Europe. This will be achieved through Networking activities, as described below.

B.1.2.1 Networking activities (WP2)

Science in high magnetic fields covers a broad spectrum since a magnetic field constitutes a universal thermodynamic parameter applicable to any system in combination with many different experimental techniques to probe the resulting change in the system. Therefore the community of researchers using high magnetic fields as an important tool for their research is vast and varied. The Networking activities of EuroMagNET II will stimulate the exchange of knowledge, information and techniques among this wide community to make it more coherent and internationally competitive. Furthermore these activities will be aimed at attracting new users and new research topics to the high field infrastructures. The Networking activities will consist of secondments, training activities and thematic networking.

The training activity aims at training researchers in the broad range of high-magnetic-field related topics and techniques, and at expanding the high field user community. The training task will organize two High Magnetic Field Schools intended mainly for graduate and undergraduate students, two topical courses of general and up-to-date high field interest, and yearly user meetings. Particular care will be taken to attract new users to these activities.

In a number of Thematic Networks high-field engineers and scientists working in specialized areas, considered important for the development of high field science and technology will be brought together in the framework of exchange visits and workshops in order to foster the exchange of ideas and the promotion of high field science and technology. These Networks will also serve to establish links with other communities that have expertise which could help advance high field science and technology or that could be interested in using high magnetic fields.

Harmonization of transnational access to the four infrastructures will be made possible by a common Selection Committee that will meet twice a year ranking all research proposals.

A secondment program, under supervision of this Selection Committee, will allow the secondments of early stage or experienced researchers between institutions to work on all aspects of magnetic field related topics. In particular the development of new ideas, theories and instrumentation will be stimulated by this program.

Through all these measures the visibility and recognition of the European High Magnetic Field Community will be enhanced. Fostered by the topical courses, workshops and secondments the needs and propositions of the user community will be identified. This will allow a targeted and permanent improvement of the services provided by the research infrastructures to the users. These upgrades as well as a continuous screening of the scientific developments are intended to attract new users.

B.1.2.2 Transnational access (WP3, WP4, WP5, WP6)

The four large infrastructures within this I3 project (GHMFL, HFML, HLD and LNCMP) represent the totality of Europe's large high field infrastructures. They serve a very active European research community of around 550 scientists, working mostly in solid state physics, but also in materials science, chemistry and biology. Under FP6, the Grenoble laboratory has operated a RITA access program, whereas the Nijmegen, Dresden and Toulouse laboratories have operated a joint TNA program within the I3 EuroMagNET. These very successful programs have led to more than 900 user access projects, resulting in more than 1000 publications, of which 10 in the highest impact journals (Nature, Science) and almost 100 in high impact journals (Phys. Rev. Lett., JACS, etc). The relatively high quantitative and qualitative impact of European high field science is certainly in large part due to the TNA support by the European Community.

In the context of this FP7 project, the four laboratories will operate a joint TNA program, which will give full access to their installations and all accompanying scientific infrastructure to qualified external users, together with the necessary support from their scientific and technical staff, at no additional cost to these users. Calls for TNA proposals will be widely published twice per year. All proposals, from internal and external users, will be evaluated by a common Selection Committee. This Selection Committee will not only decide on the scientific merits and feasibility of the proposals, but also on the infrastructure in which the proposals can be most efficiently realized. This approach will guarantee that the available European high field capacity will be used for the most promising access requests and that these will be optimally executed. This will further increase the efficiency and impact of European high field science.

B.1.2.3 Joint research activities (WP7, WP8, WP9)

High magnetic fields generally modify the electronic or magnetic properties of matter, or can even induce transitions to new unknown phases. The effects of the field on the system under study have to be probed by the proper instrumentation, like spectrometers, magnetometers etc. High field magnets present an experimental challenge to such instrumentation, due to the very strong spatial constraints, mechanical vibrations and limited and costly measurement time, which can even be well below one second for pulsed magnets. Therefore the usefulness of high field infrastructures to the users not only depends on the field strengths that are provided, but also on the presence of well adapted magnets and state of the art instrumentation. Within the EuroMagNET II I3, three Joint Research Activities are foreseen to improve the performance of existing magnets and instrumentation, and to develop new magnet types and new instrumental techniques. The joint technical and scientific potential of the large infrastructures, coupled to that of specialized user groups, offers the best possible chances for success of these activities. The results of these activities will be available at the infrastructures to the entire user community. This will allow to better serve existing users and to attract new ones.

WP 7 High Field User Magnet Technology and Operation,

Aim of this JRA is to improve the performance and usefulness of the high field magnets at the four large infrastructures. This activity will pursue coil design coordination and development of common design tools and the creation of design and materials databases. A significant effort will be put in improving the magnetic field quality in terms of cooling efficiency, field stability and noise. The target will be to increase the stability and to decrease the noise by at least a factor of ten. After a concerted action with the user community, special purpose user magnets with radial access will be designed, constructed and put into user operation. To our knowledge pulsed field split coils with reasonable lifetime do not exist and the design field of the DC radial access coil will be far above the highest existing radial access magnetic field of 15 T. Apart from the general user community which will benefit from this activity, the two other JRA work packages of this project (see below) will also strongly profit. The improved noise performance will greatly facilitate high sensitivity measurements on nano-systems (WP8) and will be essential for the NMR work package (WP9).

***WP 8 Nano object measurements and local spectroscopy*.**
An important trend in modern science is the investigation of smaller and smaller structures with properties determined by a nano-sized group of atoms or molecules. Examples are semiconductor quantum dots, organic nanostructures and carbon-based systems like nanotubes and graphene. To unravel their electrical, optical and magnetic properties it is crucial to measure the response of *individual* nanostructures, in particular for those cases where experiments on an ensemble of objects conceal important properties or processes. In ensemble measurements only the *average* value of an observable parameter is detected, and limited information is obtained about the contribution of individual objects to the overall process. For instance, temporal information about dynamical processes might get lost by ensemble averaging, as well as spectroscopic information when the averaging occurs over objects that are not precisely identical.
This JRA aims to develop and implement advanced experimental techniques that allow to do measurements on *individual nanostructures* in very high magnetic fields. The development of new equipment to perform such experiments in high magnetic fields, where the magnetic length approaches the typical size of the nanostructures, will be an extremely powerful tool to gain insight in the properties of novel nano-scale materials.
Within this JRA two different experimental approaches will be undertaken, focusing on the electrical transport or the optical properties of individual nano-objects, using a wide variety of complementary techniques. The main target of the JRA is the implementation of experimental single nano-object instrumentation in high magnetic fields, which are not as yet available. These developments have become possible due to recent advances in scanning probe techniques and local-spectroscopy methods combined with the present high performance level of the high magnetic field facilities. Prototypes of the new nanoprobe set-ups will be designed and built and the actual high-field implementation will be demonstrated by pilot experiments. Upon completion the new equipment will become available for all interested user groups.
WP 9 Enhanced Sensitivity and Single Scan Nuclear Magnetic Resonance (ES^3-NMR)
NMR has become the method of choice for many problems in materials science. Subtle changes in the local environment of the nuclei can be studied in great detail. In chemistry one uses NMR to identify for example molecular structure, inter-molecular interactions, active sites in functional materials, the molecular dynamics, diffusion and local order/disorder. In physics NMR is used to study static and dynamic properties of condensed matter, like quantum phase transitions in strongly correlated electron systems, metal-organic and molecular magnets, high-temperature and organic superconductors as well as many other systems in the current focus of material research. Since X-ray and neutron spectroscopy above 17 T are still in their infancy, NMR is currently the *only* technique that provides microscopic, structural information in higher magnetic fields. In NMR research communities there is a strong drive towards higher magnetic fields. For chemistry related problems a higher magnetic field can substantially enhance both sensitivity and resolution. For many physical problems one can use the magnetic field as an external parameter to induce phase transitions. This provides a strong incentive to extend the NMR technique to the realm of ultra high DC and pulsed magnetic fields. Solid state NMR spectroscopy at the highest available fields is expected to become a key technique for any leading high magnetic field user facility. High resolution NMR research and development projects are a central and extensive activity at the National High Magnetic Field Laboratory (NHMFL) in Tallahassee (FL) and Los Alamos (NM) and at the Tsukuba Magnet Laboratory in Japan. At present the combined NMR effort of European high field facilities is only a small fraction of the USA or Japanese efforts. In EuroMagNET I, a collaboration was formed to develop the necessary methodology both for high resolution solid state NMR in DC resistive magnets and for exploratory research in pulsed magnetic fields. This has led to major breakthroughs in both areas and proof of principle was obtained for user experiments at the European high magnetic field facilities. In commercial (superconducting magnet) spectrometers, data averaging is used to compensate for the low intrinsic sensitivity of NMR. The energy consumption of high field resistive DC magnets and the low duty cycle of pulsed magnets clearly exclude extensive averaging. The central task of this JRA is to improve the efficiency of the NMR

experiments to reduce measurement time and open up the technique for a wider field of applications, including materials with low natural abundance nuclei, less sensitive (low γ) nuclei, strong disorder and systems with very strong (quadrupolar) couplings. The implementation of NMR in high pulsed magnetic field user facilities will create new possibilities in a field of large scientific and technological interest and strengthen Europe's competitiveness in the field of NMR.

At present, the European high field facilities serve mainly the physical sciences community. A successful implementation of enhanced sensitivity and single scan NMR can make the high field facilities more attractive for the wider research community, in particular for the chemical and bio-chemical sciences.

B.1.3 S/T methodology and associated work plan

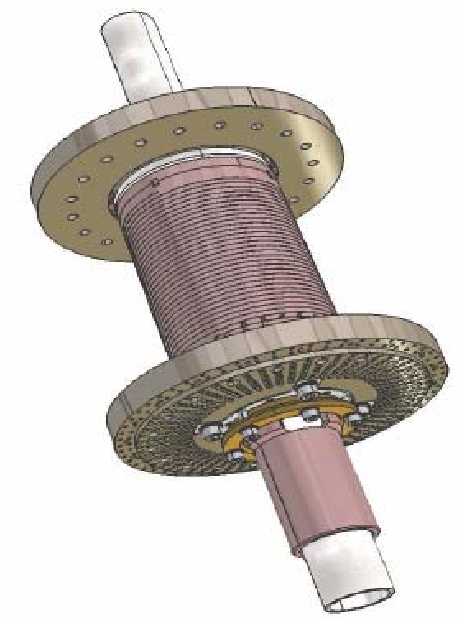
1.3.1 Overall strategy and general description

The workplan of EuroMagNET II foresees the immediate start of the TNA activities of the four infrastructures in Month1, for 8 consecutive semesters, with a Call for Proposals and evaluation of these proposals by the Selection Committee each semester. This can be straightforwardly implemented as the four infrastructures have ongoing access programs that need only be slightly adapted to the EuroMagNET II workplan. The workplan for the different JRAs foresees the development of magnets and instrumentation, in concertation with the user community, and where possible in collaboration with user groups. The results of these activities will be progressively integrated into the TNA activities at the infrastructures, as soon as they become sufficiently mature for user operation. For all JRAs this will be the case ultimately in the last year of the project. The workplan for the networking activities foresees the creation of thematic networks, a secondment program and high field science schools. The thematic networks are organised around themes that are in the centre of attention of the high field user community and that therefore represent a significant fraction of the TNA requests. Vice versa, if the TNA activities indicate a new emerging high field activity, a corresponding thematic network will be organised. The secondment program will support all activities that promote high field science. Proposals that are linked to TNA activities (either as preparation or as evaluation of the latter) will receive particular attention from the Selection Committee. The high field science schools will focus on educating young researchers in all aspects of recent scientific developments in high field research and on training scientists in the use of the instrumentation of the infrastructures available in the TNA context.

B.1.3.2 Timing of the work packages

Task	Description Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	30	36	42	48
WP1	**Management**																												
T 1.1	Overall management																												
T 1.2	Setting up Web sites																												
	Deliverables																												
D 1.2	Web site		x																										
D1.3	Public relations support																								x				
D 1.4	EuroMagNews	x			x			x			x			x			x			x			x		x	x	x	x	x
D 1.5	Periodic report																			x							x		x
D 1.6	Final report																												x
	Milestones																												
M 1.1	Kick-off meeting	x																											
M 1.2	CB meetings						x						x						x						x	x	x	x	x
WP2	**Networking**																												
T 2.1	Training																												
T 2.2	Thematic networks																												
T 2.3	Secondments																												
T 2.4	Management																												
	Deliverables																												
D 2.1	Topical courses														x												x		
D 2.2	Schools																				x							x	
D 2.3	User & plenary meetings										x												x				x		x
D 2.4	Creation forums for Thematic Networks		x																										
D 2.5	Thematic Network workshops										x												x			x	x		x
D 2.6	Lecture Notes courses															x												x	
D 2.7	Lecture Notes schools																								x				x
D 2.8	Proceedings workshops														x										x		x	x	x
D 2.9	Creation of Sel Committee		x																										
D2.10	Ranking of proposals			x							x					x							x		x	x	x	x	
D2.11	Updated user list													x											x		x		x
	Milestones																												
M 2.1	Call for proposals	x							x					x							x				x	x	x	x	
M 2.2	Announcement of topical courses		x																						x				
M 2.3	Announcement of high magnetic field schools									x																x			
M 2.4	Announcement of plenary and user meetings			x												x									x		x		
M 2.5	Sel Com meetings			x							x					x							x	x	x	x	x	x	
WP3-6	**Transnational Access Infrastructures**																												
T 3.1	User experiments																												
	Deliverables																												
D 3.1	Periodic report																			x							x		x
D 3.2	Final report																												x

WP	Description Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	30	36	42	48
WP7	**High field user magnet technology & operation**																												
	Tasks																												
T 7.1	Inventory & benchmarking																												
T 7.2	Improve user operation																												
T 7.3	Special purpose magnets																												
T 7.4	Management																												
	Deliverables																												
D7.1.1	Extended database												x																
D7.1.2	Inventory & benchmarking												x																
D7.2.1	Heat transfer studies																										x		
D7.2.2	Magnet & power converter												x																
D7.2.3	Improved field stabilization																		x										
D7.2.4	Pulsed noise reduction																								x				
D7.3.1	DC radial access insert coil																												x
D7.3.2	Pulsed radial access coils																										x		
D7.4.1	Periodic task reports						x						x						x						x	x	x	x	x
	Milestones																												
M 7.2.1	Literature review heat transfer						x																						
M 7.2.2	Improved field stabilization												x																
M 7.3.1	Radial access options												x																



Schematic view of the inner two helices of a polyhelix magnet

WP	Description Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	30	36	42	48
WP8	**Nano-object measurement & local spectroscopy**																												
	Task																												
T 8.1	Transport on n-objects																												
T 8.2	Photoconductivity n-object																												
T 8.3	Time resolved correlation																												
T 8.4	PL & MOKE imaging																												
	Deliverables																												
D 8.1.1	Characterisation noise						x																						
D 8.1.2	Nano object insert												x																
D 8.1.3	Test equipement/software																		x										
D 8.1.4	Nano object setup																								x				
D 8.2.1	Deposition procedures												x																
D 8.2.2	Photo cond. insert																		x										
D 8.2.3	DC Photo. cond. setup																								x				
D 8.2.4	Pulsed photo cond setup																										x		
D 8.3.1	TPC insert																		x										
D 8.3.2	TPC setup																								x				
D 8.3.3	TPC test in magnet																									x			
D 8.4.1	Imaging insert																		x										
D 8.4.2	MOKE test 33 T																									x			
D 8.4.3	Setup PL/MOKE imaging																										x		
D 8.4.4	Report on imaging exp.																												x
D 8.5	Periodic report&meeting																		x								x		x
	Milestones																												
M 8.1.1	Pilot MC exp.																								x				
M 8.3.1	Pilot TPC exp.																								x				
M 8.4.1	Pilot imaging exp.																								x				

WP	Description Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	30	36	42	48
WP9 ES^3-NMR																													
	Task																												
T 9.1	Cryo-pulsed probe heads																												
T 9.2	Pulsed NMR installation																												
T 9.3	NMR exp. in pulsed fields																												
T 9.4	Sensitivity enhancement																												
T 9.5	DNP at high fields																												
T 9.6	Single scan multi dim. NMR																												
T 9.7	Coordination & reporting																												
	Deliverables																												
D9.1	Pulsed field NMR installations																										x		
D9.2	Pulsed NMR user experiment																											x	
D9.3	Final report pulsed NMR																												x
D9.4.1	Advanced NMR probes																									x			
D9.4.2	Cryogenic electronics																										x		
D9.4.3	Final report enh. sensitivity																												x
D9.5	DNP probe																								x				
D9.6.1	Static stripline probe																								x				
D9.6.2	Single scan 2D NMR in SC																										x		
D9.7.1	µMAS probe																										x		
D9.7.2	Feasibility DNP enhancement																												x
D9.8.1-4	Periodic reports, meetings																		x								x		x
	Milestones																												
M 9.3	Pulsed NMR experiment																										x		
M 9.4	Advanced NMR exp.																								x				
M 9.5	Pilot DNP exp. 20 T SC																											x	
M 9.6	Pilot single scan exp.																											x	

B.1.3.3 Work package list

Work package Number	Work package title	Type of activity	Lead Beneficiary Number	Person-months	Start month	End month
WP 1	Consortium management	MGT	1	54	1	48
WP 2	Networking Activities	COORD	3	58	1	48
WP 3	Transnational access static fields CNRS	SUPP	1	8	1	48
WP 4	Transnational access pulsed fields CNRS	SUPP	1	8	1	48
WP 5	Transnational access static fields RU	SUPP	2	8	1	48
WP 6	Transnational access pulsed fields FZD	SUPP	3	6	1	48
WP 7	JRA High Field User Magnet Technology and Operation	RTD	1	306	1	48
WP 8	JRA Nano-object measurements and local spectroscopy	RTD	2	212	1	48
WP 9	JRA ES^3-NMR	RTD	2	194	1	48
	TOTAL			**854**		

Summary of transnational access provision M1-M48

Participant number	*Organization short name*	*Short name of infrastructure*	*Installation*			*Operator country code*	*Unit of access*	*Unit cost (€)*	*Min. quantity of TNA to be provided*	*Access cost charged to the GA (k€)*	*Estimated number of TNA users*	*Estimated number of TNA projects*
			number	*Short name*	*Estimated costs*							
1	CNRS	GHMFL	-	24 MW	19,6 M€	F	Magnet hour	900	2400 h	2160	250	200
1	CNRS	LNCMP	-	14 MJ	7,9 M€	F	Magnet shot	400	1600 s	640	150	100
2	RU	HFML	-	20 MW	6,6 M€	NL	Magnet hour	900	1200 h	1080	90	60
3	FZD	HLD	-	50 MJ	4,5 M€	GER	Magnet shot	400	750 s	300	70	50

B1.3.4 List of Deliverables – to be submitted for review to EC

Del. no.	Deliverable name	WP	Lead beneficiary	*Estimated person-months*	Nature	Dissemi-nation level	Delivery date
D 1.1	Implementation plans	1	CNRS	4	R	PP	M2,12, 24,36
D 1.2	Web sites (inter and intra)	1	CNRS	8	O	PU,PP	M2
D 1.3	Public relations support	1	CNRS	4	O	PU	M24
D1.4	EuroMagNews	1	CNRS	16	R	PU	M1, quarterly
D 1.5	Periodic report	1	CNRS	8	R	PP	M20, 38,50
D 1.6	Final report	1	CNRS	2	R	PP	M50
D 2.1	Topical courses	2	FZD	4	O	PU	M14,36
D 2.2	High Magnetic Field Schools	2	FZD	4	O	PU	M20,44
D 2.3	User and plenary meetings	2	FZD	2	O	RE	M10,22, 34,46
D 2.4	Exchange forums for Thematic Networks	2	FZD	2	O	RE	M2
D 2.5	Thematic Network workshops	2	FZD	5	O	RE	M10,22, 30,38,46
D 2.6	Lecture Notes of Topical Courses	2	FZD	4	R	PU	M15,37
D 2.7	Lecture Notes of Schools	2	FZD	4	R	PU	M24,48
D 2.8	Proceedings of Thematic Network workshops	2	FZD	5	R	PU	M14,26, 34,38,48
D 2.9	Establishment of the Selection Committee	2	FZD	1	O	RE	M2
D 2.10	Ranking research & secondment proposals	2	FZD	2	O	RE	M3,9...39
D 2.11	Updating user list	2	FZD	4	O	RE	M13,25, 37,48

Del. no.	Deliverable name	WP	Lead benefi-ciary	*Est. person months*	Nature	Dissemi-nation level	Delivery date
D7.1.1	Extended database	7	FZD	24	O	CO	M12
D7.1.2	Inventory and benchmarking methods	7	CNRS	24	R	CO	M12
D7.2.1	Heat transfer studies	7	RU	24	R	PU	M36
D7.2.2	Magnet and power converter test measurements, modelling and analysis	7	CNRS	36	R	PU	M12
D7.2.3	Improved field stabilization system for user experiments	7	CNRS	48	D	PU	M18
D7.2.4	Noise reduction in pulsed magnets	7	CNRS	30	R	PU	M24
D7.3.1	Design, construction and testing of a radial access insert coil	7	CNRS	60	D	PU	M48
D7.3.2	Design, construction and testing of pulsed radial access coils	7	CNRS	54	D	PU	M36
D7.4.1	Periodic task progress reports	7	CNRS	6	R	CO	M6,M12, …M48
D 8.1.1	Characterization of noise & current spikes during bank discharge	8	CNRS	12	R	PP	M6
D 8.1.2	Insert for single nano-object transport up to 70 T	8	FZD	12	P	PP	M12
D 8.1.3	Testing equipment/software for ultra-low noise & fast data acquisition	8	CNRS	18	R	PP	M18
D 8.1.4	Implementation of nano-object MC set-up in pulsed magnets	8	CNRS	12	D	PU	M24
D 8.2.1	Test and refine deposition procedures on CNT and graphene flakes	8	UOX-DK	12	R	PP	M12
D 8.2.2	Single-object photoconductivity insert	8	UOX-DK	12	P	PP	M18
D 8.2.3	Implementation nano-object PC equipment in DC magnet	8	CNRS	12	D	PU	M24
D 8.2.4	Implementation nano-object PC equipment in pulsed magnet	8	CNRS	24	D	PU	M36
D 8.3.1	Time-resolved Photon-Correlation (TPC) insert	8	CNRS	12	P	PP	M18
D 8.3.2	Implementation of TPC equipment in DC magnet	8	CNRS	12	D	PU	M24
D 8.3.3	TPC insert test in magnet	8	CNRS	12	R	PU	M30
D 8.4.1	Optical imaging insert for 32 mm bore 33 T magnet	8	RU	18	P	PU	M18
D 8.4.2	Testing MOKE detection scheme up to 33 T	8	RU	24	R	PP	M30
D 8.4.3	Set-up for PL and MOKE imaging up to 33 T	8	RU	12	D	PU	M36
D 8.4.4	Final report on optical imaging of semiconductor nanostructures	8	RU	2	R	PP	M48
D 8.5	Periodic reports, meetings and dissemination	8	RU	8	R	PP	M18, 30, 48

Del. no.	Deliverable name	WP	Lead benefi-ciary	*Est. perso nmo nths*	Nature	Dissemi-nation level	Delivery date
D 9.1	Pulsed field NMR installations in Toulouse and Dresden	9	LNCMP FZD	50	D	PU	M36
D 9.2	Pulsed field NMR user experiment	9	ULEI	18	R	PU	M42
D 9.3	Final report, pulsed magnetic field spectroscopy	9	FZD	6	R	PU	M48
D 9.4.1	Advanced NMR probes	9	GHMFL	30	D	PU	M30
D 9.4.2	Cryogenic electronics	9	GHMFL	8	D	PU	M36
D 9.4.3	Final report on user experiments with enhanced sensitivity	9	GHMFL	4	R	PU	M48
D 9.5	DNP probe with 95 GHz resonator and in situ NMR microcoil	9	RU	12	P	PU	M24
D 9.6.1	Static LT probe with stripline NMR detection and pulsed gradient coils	9	RU	12	P	PU	M24
D 9.6.2	Single scan 2D NMR in SC	9	WI	16	R	PU	M36
D 9.7.1	Micro MAS DNP probe (20 T)	9	TUT RU	28	D	PU	M36
D 9.7.2	Feasibility DNP enhancement	9	RU	6	R	PU	M48
D 9.8.1-4	Periodic reports, meetings and dissemination	9	RU	4	R	PU	M18, 30, 48

B.1.3.5 Work package descriptions

Work package number	WP 1	**Start date or starting event:**		M1			
Work package title	**Consortium management**						
Activity Type	MGT						
Beneficiary number	1	2	3				
Beneficiary ID	CNRS	RU	FZD				
Person-months per beneficiary: (permanent staff:)	42 (12)	6 (2)	6 (6)				

Objectives The consortium management work package will ensure efficient and effective management of all the operational, technical and financial aspects of the EuroMagNET II I3, the communication between the consortium and the EC services, the communication with the scientific community and the general public and the dissemination of scientific and technical results;

Description of work

Control and coordination of the flow of information and resources and reporting (CNRS)

The Coordinator will be the intermediary between the Commission Services and the beneficiaries of the I3. He will be assisted by a 0.5 fte administrative person, in addition to all the necessary personnel of the central and local administrative staff of the CNRS.
The CNRS administrative services will take charge of the reception of the project funds from the European Commission and of all of the administrative matters related to the project. The same services will ensure that the transfer of the agreed amounts of money to each of the partners within the shortest possible time after reception from the EC.

Organization of Coordination Board meetings (CNRS)

The Coordinator (CNRS) will be the chair of the Coordination Board (CB). He will organize the CB meetings twice per year, fix the agenda and prepare the minutes, which will be available to the beneficiaries in the restricted area of the EuroMagNET II web site. The CB meeting will essentially serve to evaluate the progress of the project, to decide on the implementation plans for the remainder of the project and to validate the selection procedures for access, secondments, organization of schools, workshops etc.

Definition of implementation plans (CNRS, RU, FZD)

The annual implementations plans for the next 18 months will be prepared by the Coordinator, discussed and amended by the CB, and submitted for approval to the Council. These plans will in principle follow the outline of the project as fixed in the Contract and Consortium Agreement, but will be adapted to unforeseen developments.

Creation and updating of intra- and internet web site (CNRS)

A web site www.euromagnet2.eu will be created and maintained by the CNRS for EuroMagNET II. It will contain a restricted area (intranet) only accessible to the beneficiaries and the EC Services, which will serve to communicate on all administrative matters concerning the project. The public part of the web site will be used for communication with the scientific community and the general public. It will be used for the dissemination of results, to publish the call for proposals for access, secondment, schools and workshop, hiring of temporary staff etc.

Representation towards other scientific communities, industry and the general public (CNRS, RU, FZD)

In order to raise awareness of the potential of the European high field infrastructures and high field science amongst industry, the scientific community or the general public, the task leaders and senior scientists and engineers of the beneficiaries will pursue an active role in committees, forums and other organizations that rally a certain number of scientific or political actors that could be instrumental in the advance of high field science in Europe.

A flyer describing EuroMagNET II and in particular its TNA and secondment activities will be created and will be widely distributed, e.g. by scientists of the infrastructures at conferences.

In order to increase awareness of and interest in high field science amongst young people, an popularizing presentation, including attractive demonstrations, will be created that can be held at secondary schools. This will be made available to the beneficiaries. Particular emphasis will be put on trying to interest female students for the high field activities, as women are strongly underrepresented in the high field user community and the staff of the high field infrastructures.

Dissemination of results

The scientific and technical results of EuroMagNET II will be brought under the attention of a wide audience, through the EuroMagNET II web site, with links at the web sites of all beneficiaries, a quarterly EuroMagNews bulletin, distributed amongst the scientific community, press releases to the popular press etc.

Where deemed of particularly high impact, participation in prestigious international conferences will be financed to promote recent results obtained within the EuroMagNET II framework and thereby European high magnetic field science.

Deliverables (brief description and month of delivery)

D1.2 Intra- and internet web site (M 2)

D1.3 Public relations support (flyer, presentation with demonstrations) (M24)

D1.4 EuroMagNews (M1, M4,…quarterly)

D1.5 Periodic reports (M20, M38, M50)

D1.6 Final report (M50)

Work package number	WP 2	**Start date or starting event:**			M1	
Work package title	**Networking activities**					
Activity Type	COORD					
Participant number	1	2	3	5		
Participant short name	CNRS	RU	FZD	UOX-DK		
Person-months per participant: **(permanent staff:)**	16 (8)	10 (2)	24 (12)	8 (4)		

Objectives

The networking activity will foster the exchange of knowledge, information and technologies among the high magnetic field infrastructures, their users and the research community. It will enhance the visibility of high magnetic field science and technology, advance the dissemination of research results obtained at the infrastructures, stimulate more coherence and international competitiveness of the high-field community and will attract new users and research topics to the high-field infrastructures. For the education of young researchers and students on the graduate and undergraduate level two High Magnetic Field Schools will be offered. Modern research topics on the broad range of high field related research as well as the experimental instrumentation available at the infrastructures will be presented by renowned experts in a tutorial way. In addition, three topical courses on general and up-to-date high-field issues for a broader science community as well as yearly user and plenary meetings will be organized. The workshops will highlight state-of-the-art questions and research topics in a given area of interest. The user meetings will serve as an important feedback of the user needs and interests in new and better techniques, experimental infrastructure and user support. In addition, recent experimental highlights of work performed in the high-field facilities will be presented. In the plenary meeting, which will be organized in connection with the user meetings, the EuroMagNET Council will gather to evaluate and discuss all scientific and administrative activities and to propose further directions.

Further to that, scientists and engineers working in more specialized areas will be brought together in **Thematic Networks**. The task leaders of these networks will organize exchange visits and workshops which will promote the exchange of knowledge and ideas as well as the development of high-field science and technologies. Six Thematic Networks on the following topics have been identified based on the experience of the running I3 activities as well as on suggestions from the user community.

As part of the network activities, a **common Selection Committee** will be established that will meet twice a year. This committee will judge the access requests for all four infrastructures and the secondment proposals.

An **outreach** program, intended to attract new users to the infrastructures will be organized. In order to enhance the visibility of high-field research it is planned to award a EuroMagNET prize every year for outstanding research performed by users of high magnetic fields.

An **exchange program** will permit short, mid and long-term secondments of researchers between institutions, for typically a few weeks up to a few months. This will stimulate early stage as well as experienced researchers to concentrate their work on all aspects of magnetic-field related topics, such as the preparation of sophisticated experimental setups, the design, development and testing of special high field equipment, the discussion of experimental results as well as for writing high field related publications.

Description of work

Task 1: Training

Every second year a High Magnetic Field School will be organized by one of the partners. The first one is planned for summer 2010, the second for summer 2012. The announcement will be widely publicized about one year in advance, and attendance will be open to all interested students. There will be a limit of about 80 young researchers and 20 lecturers selected by the organizers in agreement with the Coordination Board. Selection criteria will be the age, the level of qualification of the applicant, and the geographical distribution. Participation or being involved in experiments done at one of the infrastructures will be an important criterion. The lecture notes will be made available on the EuroMagNET web site shortly after the schools.

During the four-year period two topical courses on science in high magnetic fields will be organized by one of the partners. (The first one is planned to "Resonant techniques in high magnetic fields" organized by FZD. 30-40 people will participate at each workshop, upon invitation of the organisers in agreement with the Coordination Board. Participants will be chosen among experts and younger scientists who are actively working at the forefront of their field.

Each year a two-day user meeting for the whole user community will be organised. The meetings will be held in one of the high-field infrastructures rotating each year between the four installations.

Resources:

<u>Schools:</u> Travel and subsistence for 20 teachers and partial support for a total number of 80 students: 70 k€ per school; local costs and lecture hall rent estimated at 10 k€. Total costs for two schools including overhead: **160k€**

<u>Topical courses:</u> Travel and subsistence costs of external participants and speakers, local costs and lecture hall rent: 50 k€ per course. Total costs for two courses including overhead: **100k€**

<u>User meetings:</u> Travel and subsistence for about 40 participants: 30 k€ per meeting including overhead. Total costs: **120 k€**

Task 2: Thematic Networks

Each of the task leaders has contacted a number of scientists and engineers interested in participating in the different Thematic Networks. Altogether more than 90 individuals from 15 European countries (plus many more other countries) have already expressed their interest in taking part in the network activities. Mailing lists for each Network will be established and the task leader will distribute regularly topic-related information such as papers, conference announcements as well as information on new materials. Such information will as well be available on an internet exchange forum where all participants can post information and announcements. Within exchange visits single persons or smaller groups will be brought together to tackle more specific tasks (perform specific experiments, write joint publications or coordinate further events). Each task leader may propose persons for exchange visits to the Coordination Board which then decides on the proposal. During the funding period one larger workshop will be organised by the task leaders. The number of participants may vary between 20 and 50 persons depending on the Thematic Network. These workshops will preferably be held in conjunction with dedicated international conferences if possible organised by one of the partners. By that overseas participants could be involved in the networks without paying travel expenses. The thematic networks are:

Materials for high field magnets: task leader F. Lecouturier (CNRS-LNCMP)
The aim of this network is to bring together scientists and engineers working with ultra-strong conductors and reinforcement materials for superconducting, resistive or pulsed magnets with those working on the metallurgy of high strength metals. The limiting parameter for reaching higher magnetic fields is the conductor-material strength and common efforts on an international level are necessary to develop and achieve better materials for constructing superior high field magnets for the user community.

***Harmonisation of experimental conditions*:** task leader S. Zvyagin (FZD-HLD) The goal here is to propose and promote harmonisation, standardisation and best practices to improve the usefulness and effectiveness of the different experimental infrastructures in the ensemble of high field facilities for the users. A detailed inventory of the available experimental techniques for high field measurement in the four facilities and of the needs of current and potential users will be made and propositions will be elaborated to come to a more efficient approach. Input and involvement of the user community will play an essential part in this Thematic Network.

***High field physics of strongly correlated electron systems*:** task leader C. Proust (CNRS-LNCMP). Research in high magnetic fields have been and still are a prerequisite to unravel basic principles on the physics of strongly correlated systems. The objective of this network is to bring together physicists, chemists and material scientists working experimentally and theoretically on the high field physics of these kind of materials, such as heavy-fermion compounds, organic conductors and high-T_c superconductors. It will be the goal of the network to identify emerging trends and grand challenges in these fields.

***High field physics of low dimensional carbon structures*:** task leader R. Nicholas (UOX-DK) Novel carbon nanostructures based on the graphene band structure and it's quantized derivative, the carbon nanotube, are prime candidates for a variety of novel electronic applications. Magnetic fields have proved to be the single most important tool in demonstrating quantum effects in materials such as the massless Dirac Fermion in graphene. The aim of this network is to foster the strongly needed close collaborations between experimentalists and theorists from a variety of backgrounds, working on the high field physics of carbon materials.

***Molecular materials in high magnetic fields*:** task leader P. Christianen (RU-HFML) The purpose of this network is to establish a new European community of scientists from a broad range of disciplines, like soft condensed matter, (organic) chemistry and biology, that use magnetic fields to study molecular materials. The network aims to bring together those people to exploit the great potential of using high magnetic fields to levitate or align seemingly non-magnetic materials, to unravel the properties of molecular magnets and organic spin systems and to study the effect of high magnetic fields on biological systems.

Resources:

For each Thematic Network 3 person-month for exchange visits (at 2000 € per person-month) plus travel and subsistence for one workshop (30 k€ on average), i.e., 36 k€ for each Thematic Network on average. Total costs for 5 Thematic Networks including overhead: **180 k€**

Task 3: Secondments, Joint Transnational Access and Outreach

The joint call for proposals for all four TNA WPs (WP3-WP6) and the secondment and scholarship programs will be widely publicised twice per year (February and September) by means of direct (e)mail, ads in professional journals (Physics World, Europhysics News) and on the websites of EuroMagNET II and the participating infrastructures. The applicant has to fill out a harmonized form which gives the aim of the project and experimental details needed for performing the experiment in the case of TNA. The selection procedure will be based on the proven procedures established in the GHMFL RITA program and the EuroMagNET I3. Ranking of all the access and secondment proposals will be done by the Selection Committee, based on the expected scientific impact and taking into account the feasibility, and the benefit to the European high field community. Concerning the access requests, first time users will be given a preferential treatment to allow them to gain experience at the high field infrastructures. All applicants of eligible proposals will be informed by the infrastructure that the work can be executed during the next 12 months, and that the proposer should confer with the local contact, assigned by the infrastructure, on the exact planning of the experiment. During the entire execution of the proposal, the local contact will support the user. Where necessary he can mobilize other resources of the infrastructures, human or otherwise, to ensure a successful completion of the user experiment. Infrastructure in-house researchers are considered as internal users, and are scheduled on the same basis as the external users. Typical experiments will take between 3 and 10 working days for implementation and require a typical planning and preparation time of two months. On average, each executed access proposal generates one publication, on which the local contact is expected to be co-author and in which the European Community support through the FP7 Infrastructures program should be acknowledged.

In view of the thematic diversity, the Selection Committee will be divided into four thematic sub-committees (Metals, Semiconductors, Magnetism, Soft matter) each having one representative of a large infrastructure and two independent external experts, selected for their competence and international reputation in the relevant domain, in concertation with the User Committee. This procedure will thus guarantee an objective, fair and transparent evaluation

Outreach

Apart from the widely publicized call for proposals, the scientific staff at the infrastructures will be continuously screening the literature for scientific developments and experiments that could benefit from the use of high magnetic fields as a research tool and will take initiatives to pass on this message to these potential new users. Based on that screening the high magnetic field user list will be expanded and updated every year.

Upon recommendation of the members of the Coordination Board, Council, User and Selection committee the Coordination Board will award a EuroMagNET prize (2000 €) for outstanding high-field-related research each year at the user meetings or during international conferences related to high field research. Ideally, the first prize would be conferred at the International Conference Research in High Magnetic Fields, held in 2009 in Dresden, organized by FZD-HLD.

Resources:

For a total of 12,5 person-month per year (with 2000 € per person-month) the total costs are: **100 k€**

8 Selection Committee meetings (12 committee members): **60 k€**

Task 4: Overall management,

For the practical organization and the scientific management of the schools, courses, meetings and secondments, for the prize awards as well as for the announcements, dissemination of results and for outreach activities (public talks, flyers etc.) the following support is needed:

FZD (12 person-month plus prize money and consumables): 80 k€, CNRS (8 person-month): 40 k€ RU (8 person-month): 40 k€, UOX-DK (4 person-month): 20 k€. Total costs: **180 k€**

Deliverables	(brief description and month of delivery)
D 2.1	Topical courses (M14, M36)
D 2.2	High Magnetic Field Schools (M20, M44)
D 2.3	User and plenary meetings (M10, M22, M34, M46)
D 2.4	Establish exchange forums for Thematic Networks (M2)
D 2.5	Thematic Network workshops (M10, M22, M30, M38, M46)
D 2.6	Lecture Notes of Topical Courses (M15, M37)
D 2.7	Lecture Notes of Schools (M21, M45)
D 2.8	Proceedings of the Thematic Network workshops (M14,26,34,38,48)
D 2.9	Establishment of the Selection Committee (M2)
D 2.10	Ranking research & secondment proposals (M3, M10, ….M39)
D 2.11	Updated user list (M13, M25, M37, M48)

Work package number	WP 3	**Start date or starting event:**				M1
Work package title	**Transnational access static fields CNRS**					
Activity Type	SUPP					
Beneficiary number	1					
Beneficiary ID	CNRS					
Person-months per beneficiary: (permanent staff:)	8 (8)					

Description of the infrastructure
Name of the infrastructure: *Grenoble High Magnetic Field Laboratory*
Location (town, country): *Grenoble, France*
Web site address: *http://ghmfl.grenoble.cnrs.fr/*
Legal name of organisation operating the infrastructure: *Centre National de la Recherche Scientifique*
Location of organisation (town, country): *Paris, France*
Annual operating costs (excl. investment costs) of the infrastructure (€): 5,6 M€

Description of the infrastructure:

The Grenoble High Magnetic Field Laboratory (GHMFL) is operated by the CNRS as a user facility for national and international users. It has an electrical power supply of 24 MW and 8 resistive magnets of which 5 are working with 10 to 12 MW and 3 with 24 MW. The available maximum fields range from 20 T in a 160 mm bore diameter to 30 T in 50 mm and 34 T in a 34 mm bore diameter at room temperature. The installation is running 24 hours a day, with permanent operators. It is used for more than 50% (1800hours) by European, non-French scientists. The GHMFL maintains strong in-house research in the highest static magnetic fields available in Europe and it has developed highly sophisticated instrumental facilities for specific use in high magnetic fields. These include magneto-transport, magnetization and torque, visible and infrared optical measurements, ESR and NMR investigations, at very low temperatures and / or high pressures. Most research carried out at the GHMFL is in the areas of strongly correlated electrons (heavy fermions, high T_c super-conductors,..), magnetism and semiconductors. The previous TNA program (2004-2007, extended to 2008) has resulted in more than 500 publications, produced by French (40%), European (50%) and other (10%) scientists. An ongoing project to generate 43 T with a new hybrid magnet is planned to be completed in 2011. This new magnet will be immediately at the disposal of the users. We have made big progress in terms of the field stability and homogeneity to open our facilities to other scientific communities such as solid state chemistry and biology, using high resolution NMR experiments and high field high frequency EPR.

The GHMFL shares a campus with other CNRS laboratories (about 400 people) working on nanoscience, magnetism, structural and optical properties of new materials, and using a variety of experimental tools (STM, AFM, micro squid magnetometers, optical measurements…) with extended magnetic field, temperature or pressure ranges. The campus is part of a even larger scientific complex including the nuclear centre CEA (with solid state department and Minatec a nanotechnology centre, the neutron source ILL as well as the synchrotron radiation facility ESRF. The interactions between all these researchers are strong and facilitated by common seminars and common social activities (restaurants, sports etc…)

Description of work

Modality of access under this project: : *Common procedure for all TNA WP, see WP2, Task 3*

Support offered under this project:

The GHMFL offers full access to its high field installation and all the scientific equipment associated with it to all qualified users. Its scientific, technical and administrative staff will support the user in preparing, executing and evaluating experiments and with travel and housing arrangements. The scientific instrumentation belongs to the best world wide for static field experiments and allows for a large variety of high quality measurements. A special "instrumentation service" of 7 technicians and engineers is helping visitors with standard experiments (magnetization, transport, tests of superconducting wires or tapes …) or with the top-loading dilution refrigerator. Many of the GHMFL staff members are leading experts in their domain, and have a long experience in supporting user experiments; over 600 user experiments have been performed at the GHMFL over the last five years, the very large majority of them resulting in publications.

Outreach to new users: : *Common procedure for all TNA WP, see WP2, Task 3*

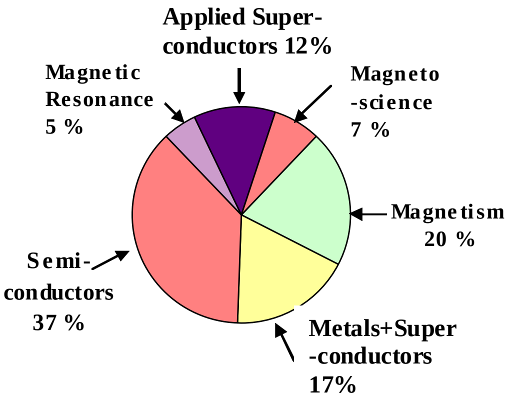
Selection procedure under this project: : *Common procedure for all TNA WP, see WP2, Task 3*

Implementation plan

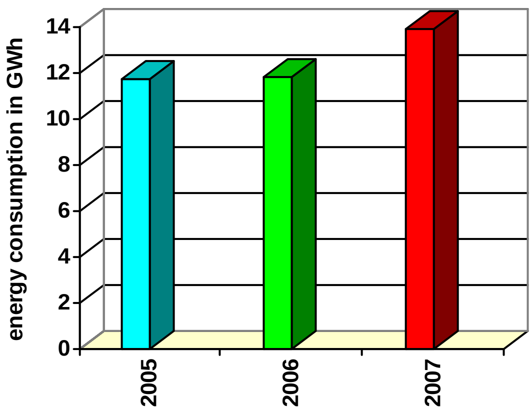
Short name of installation	*Unit of access*	*Unit cost*	*Min. quantity of access to be provided*	*Estimated number TNA users*	*Estimated number of TNA days spent at the infrastructure*	*Estimated number of TNA projects*
GHMFL	Magnet hour	900 €	2400	250	1200	200

Unit of Access:

The unit of access for the GHMFL is a magnet-hour. Apart from the direct running costs of the installation, this includes all additional costs necessary to realize the experiment including but not limited to cryogenic liquids, use of all laboratory facilities and workshops, use of all electronic equipment and computer facilities and support by the local scientific, technical and administrative staff, in preparation, execution and evaluation of the experiment. The user will receive training in the operation of the installation and its security aspects.



Repartition of the projects per domain



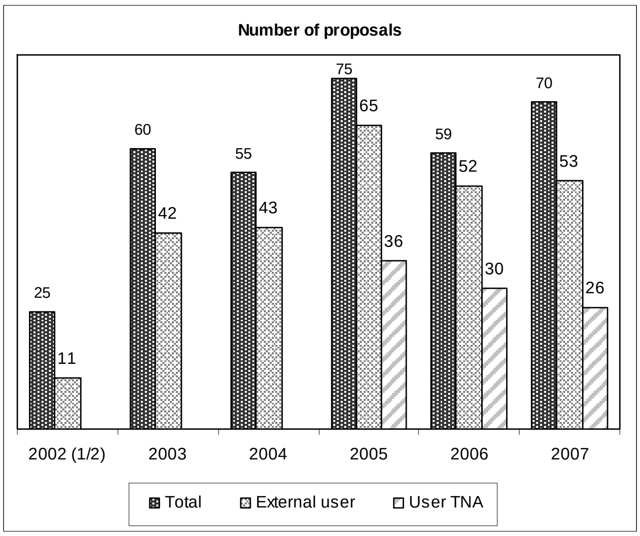
Electrical Energy consumption GHMFL per year

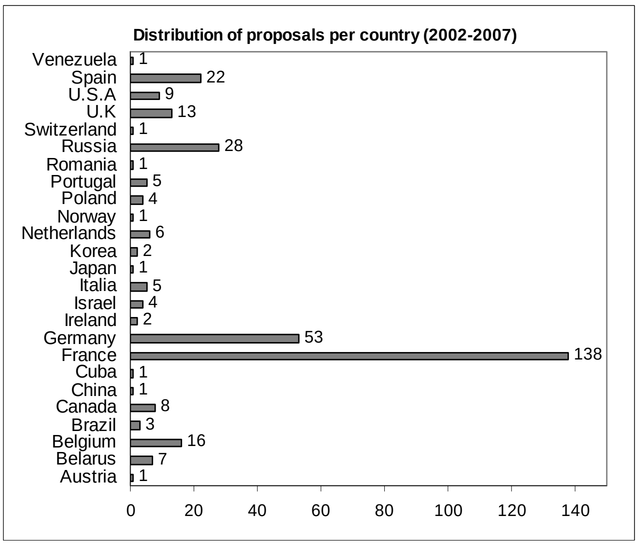
Work package number	WP 4	**Start date or starting event:**			M1
Work package title	**Transnational access pulsed fields CNRS**				
Activity Type	SUPP				
Beneficiary number	1				
Beneficiary ID	CNRS				
Person-months per beneficiary: (permanent staff:)	8 (8)				

Description of the infrastructure
Name of the infrastructure : *Laboratoire National des Champs Magnétiques Pulsés*
Location (town, country): *Toulouse, France*
Web site address: *http://www.lncmp.org*
Legal name of organisation operating the infrastructure: *Centre National de la Recherche Scientifique*
Location of organisation (town, country): *Paris, France*
Annual operating costs (excl. investment costs) of the infrastructure (€): 2,9 M€

Description of the infrastructure:

The LNCMP is operated by the CNRS as a national and international user facility for experiments in pulsed magnetic fields. The LNCMP offers full access to its installation and all the scientific equipment associated with it to all qualified users. Its staff will support the user in preparing, executing and evaluating experiments. The high quality of this infrastructure is recognized by a large number of users during the last five years, their large geographic spread (see tables below), and the scientific impact resulting from this activity; The LNCMP experiments performed during the last five years have resulted in over 200 publications, of which 25 in Physical Review Letters and 2 in Nature. Under the ongoing EuroMagNET contract (RII3-CT-2004-506239), until the end of 2007, 1750 TNA eligible magnet shots have been delivered, whereas the contract requires 900 magnet shots.





The LNMCP pulsed field infrastructure is built around a 14 MJ capacitor bank, that can be switched between 10 magnet sites on which different pulsed magnets are installed (see table below), amongst which Europe's record magnet (78 T). The magnet sites are equipped with state-of-the-art scientific equipment, like a dilution refrigerator (down to 50 mK), UV-VIR-NIR and FIR spectrometers, high pressure cells (up to 10 GPa), cantilever and compensated coil magnetometers etc, all optimised for use in pulsed magnetic fields. A large effort has been made to obtain a very good signal-to-noise ratio in the measurements, which for many techniques is now comparable to that obtained with measurements in DC fields.

Most recently, a single shot single turn installation, capable of generating up to 300 T, together with the scientific instrumentation to do spectroscopy and magnetization measurements was put into operation. This is the only of its kind in Europe, the two other existing installations being in Los Alamos (USA) and Kashiwa (Japan).

Energy (MJ)	Number	Maximum field (T)	Bore diameter (mm)	Rise time / Total time (s)	Cooldown Time (h)
1.25	2	40	25	0.09 / 0.8	1
1.2	2	62	11	0.025 / 0.150	0.8
5	4	62	26	0.045 / 0.250	1.2
10	1	78 (coilin-coilex)	15	Coilin 0.005 Coilex 0.3	4

Most research carried out at the LNCMP is in the areas of strongly correlated electrons (heavy fermions, high T_c superconductors,..), magnetism and nanosciences (carbon nanotubes, graphene, quantum dots,..), but even experiments in atomic physics, biophysics and elementary particle physics have been sucessfully performed. The LNCMP attaches great importance to opening its installation as a research tool for other research areas and attracting new users.

Description of work

Modality of access under this project: *Common procedure for all TNA WP, see WP2, Task 3*

Support offered under this project: The LNCMP offers full access to all the magnet sites of its high field installation and all the scientific equipment associated with it to all qualified users. Its scientific, technical and administrative staff will support the user in preparing, executing and evaluating experiments and with travel and housing arrangements. The scientific instrumentation of the LNCMP belongs to the best world wide for pulsed field experiments and allows for a large variety of high quality measurements. The LNCMP staff counts 15 permanent scientists and 21 permanent technicians and engineers. Many of them are leading experts in their domain, and have a long experience in supporting user experiments. A team of 5 staff members is entirely dedicated to user support. Housing can be made available to external users in an apartment in the university guest house, on campus and within easy walking distance.

Outreach of new users: *Common procedure for all TNA WP, see WP2, Task 3*

Review procedure under this project: *Common procedure for all TNA WP, see WP2, Task 3*

Implementation plan

Short name of installation	*Unit of access*	*Unit cost*	*Min. quantity of access to be provided*	*Estimated number TNA users*	*Estimated number of TNA days spent at the infrastructure*	*Estimated number of TNA projects*
LNCMP	Magnet shot	400 €	1600	150	1000	100

Unit of Access:

The unit of access is a magnetic field shot. Test shots at the lowest field are not counted. Apart from the direct running costs of the installation, and the depreciation of the coils (pulsed field coils have a finite lifetime and should be considered as consumables), this includes all additional costs necessary to realize the experiment during the shot including but not limited to cryogenic liquids, use of all laboratory facilities and workshops, use of all electronic equipment and computer facilities and support by the local scientific, technical and administrative staff, in preparation, execution and evaluation of the experiment. The user will receive training in the operation of the installation and its security aspects.

Work package number	WP 5	**Start date or starting event:**			M1
Work package title	**Transnational access static fields RU-HFML**				
Activity Type	SUPP				
Beneficiary number	2				
Beneficiary short name	RU				
Person-months per beneficiary: (permanent staff:)	8 (8)				

Description of the infrastructure
Name of the infrastructure: *High Field Magnet Laboratory*
Location (town, country): *Nijmegen, the Netherlands*
Web site address: *http://www.hfml.ru.nl*
Legal name of organisation operating the infrastructure: *Stichting Katholieke Universiteit Nijmegen*
Location of organisation (town, country): *Nijmegen, the Netherlands*
Annual operating costs (excl. investment costs) of the infrastructure (€): 2.8 M€

Description of the infrastructure:

In 2003 the High Field Magnet Laboratory (HFML) started operating an entirely new 24 MVA installation which allows to operate 20 MW resistive and hybrid magnets in 6 dedicated magnet cells: the resistive magnets generate magnetic fields up to 33 T, and a new hybrid magnet is being built that from 2013 may generate as much as 45 T.

HFML has been operated as a European funded large research infrastructure since 1988 and has considerable experience in handling guest research, in hospitality as well as in scientific support and collaboration, and quality assurance.

The ultra-modern infrastructure in Nijmegen has been designed for optimum experimental conditions: the power supply has an extremely low ripple (10 ppm peak-peak) and high stability, and the cryostats on the magnet sites are quite immune to the high vibration levels associated with the large machinery and water flow of the cooling installation: in practice vibration levels proved to be only a factor of 2 higher than in superconducting magnets at the user's home laboratories. As a side result of these precautions low acoustic noise also facilitates experimenting at high fields.

Site	Type of magnet	Bore (mm)	B_{max} (T)
1	20 MW resistive magnet	32	33
2	Resistive magnet: bore either horizontal or vertical	32	20
3	20 MW resistive magnet	32	33
4	Hybrid magnet, 8 T s/c outsert ("low power" for extended high-field experiments), is being upgraded, available dec 2008	50	30
5	20 MW resistive magnet	50	31

All magnets can be approached from the floor above (where typically all lasers and spectrometers are located) and the stiffness of the building has proved to be sufficient to enable scanning optical confocal spectroscopy in the magnets with sub-micrometer spatial resolution and reproducibility.

New developments at HFML are the 50 mm bore resistive magnet, based on Florida-Bitter technology, and completely designed and built at HFML, which was commissioned in the spring of 2007. A resistive coil of similar design is now being inserted in an existing 8 T superconducting outsert, and the upgraded hybrid magnet system will be available for users from end of 2008, for experiments around 30 T, like NMR and crystal growth, that require very long duration.

In addition to the high magnetic fields there is extensive instrumentation for all sorts of experiments: the cryogenic facilities include helium bath- and flow-cryostats (1.8 - 300 K), ^{3}He (down to 300 mK), dilution refrigerators (down to 20 mK) and temperature regulators; the spectroscopic tools include photoluminescence (PL) and photoluminescence excitation (PLE) in the visible, optical birefringence, Raman spectroscopy, far-infrared fourier-transform spectroscopy, infrared spectroscopy with IR pumped molecular gas lasers (and from 2011 with a 100 - 1500 μm, 200 GHz - 3 THz, free electron laser, now under construction), and microwave spectroscopy with solid state sources (e.g. ESR); available probes include single- and double-axis sample rotation, cantilever magnetic force detection, magnetisation, thermo-power, specific heat, critical-current probes for superconducting wire characterisation and specialized optcal probes allowing polarization studies and sample scanning using in-situ nanopositioners; with a choice of standard equipment and data-acquisition computers, this will quite simply enable study of de Haas-van Alphen and Shubnikov-de Haas oscillations, the (quantum) Hall-effect and a range of thermodynamic properties to the highest fields. As a result of previous work in the NMR-JRA of EuroMagNET (including special shimming for field homogeneity and sophisticated techniques to correct for field fluctuations and drift) a working Solid State high-field NMR (up to 1.4 GHz with MAS) spectrometer has been developed allowing high resolution ($<10^{-6}$) solid state NMR, including the possibility 2D spectra, can now be offered for external users.
Excellent mechanical workshops and standard sample preparation facilities are available, both at HFML itself and at the Faculty of Science. This way highly sophisticated measurement probes can be developed and modified.

HFML, with 6 permanent scientists and 7 permanent support staff, has about 10 PhD students and postdocs. The HFML is part of the Institute for Molecules and Materials (IMM) of the Radboud University in Nijmegen, a research organisation comprising 19 research groups active in areas ranging from condensed matter nanoscience to (bio)chemical synthesis. IMM presently has 190 scientists (70% of them young scientists and postdocs) and 50 support staff.

Under previous contracts (HPRI-CT-1999-00036 and RII3-CT-2004-506239) and until the end of 2007, more than 60 different TNA projects were executed, involving more than 100 guest researchers from about 50 different user groups and from 14 different countries. Correcting for a small depression of the activities during the shutdown 2001-2003 of the old installation, in a single year, HFML is executing typically between 40 and 50 projects, 30-40% of those by or with European usergroups, the effort resulting in as many publications in refereed journals each year.

Support currently offered by the infrastructure:
Access to the highest static fields in 20 MW class resistive and hybrid magnets (i.e. to magnetic fields well above 20 T) together with all available general and dedicated instrumentation, and adequate scientific and technical support.
The installation can in principle be operated 24 hours per day, by the team of scientists themselves (no “operator”) and in any period typically 3 different users (on different magnet sites) will have to split the available magnet time.
Accomodation can be made available to guest researchers in an apartment in the university guest house, on campus and within easy walking distance.

Attractive results:
Fermi surface studies of organic metals, perovskites and layered materials by de Haas-van Alphen and the Shubnikov-de Haas oscillations and their temperature dependence;
Quantum Hall effect in graphene and its persistence to room temperature;
Growth of proteins in quasi-zero-gravity conditions;
Magneto-spectroscopy of single quantum dots and macromolecules.

Description of work

Modality of access under this project: *Common procedure for all TNA WP, see WP2, Task 3*

Support offered under this project:

HFML offers full access to the highest static fields in 20 MW class resistive and hybrid magnets, and all the available scientific equipment to all qualified users. Its scientific, technical and administrative staff will support the user in preparing, scheduling and executing the proposed project and with housing arrangements. . If necessary, possible and required support in analysis of the results is also given.

The scientists at HFML are leading experts in magneto-spectroscopy, especially in the visible and (far)infrared, in transport properties of quasi-2D systems (FQHE, Aharonov-Bohm effect, Shubnikov-de Haas effect), and magnetic manipulation of polymers and biomolecules.
Outreach of new users: *Common procedure for all TNA WP, see WP2, Task 3*

Review procedure under this project: *Common procedure for all TNA WP, see WP2, Task 3*

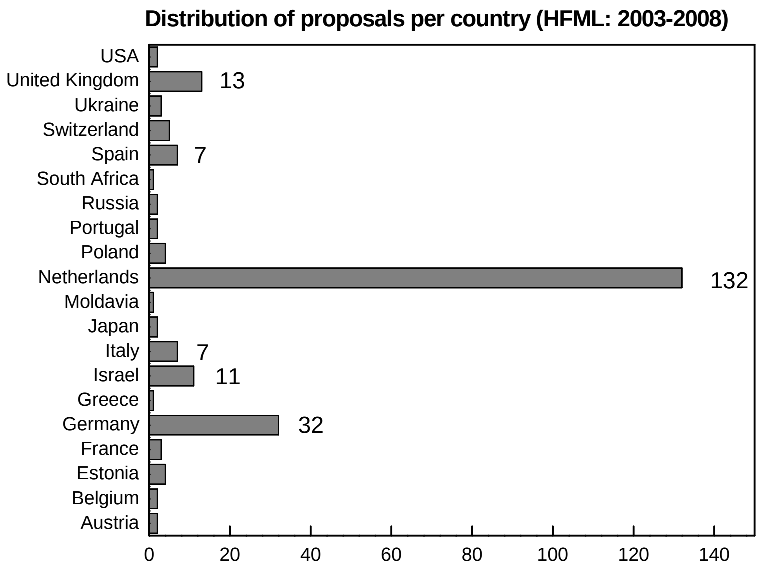
Implementation plan

Short name of installation	*Unit of access*	*Unit cost*	*Min. quantity of access to be provided*	*Estimated number TNA users*	*Estimated number of TNA days spent at the infrastructure*	*Estimated number of TNA projects*
HFML	Magnet hour	900 €	1200	90	900	60

Unit of Access:

The unit of access is a magnet-hour, based on a recording of the time of experimentation, measured to 1-minute accuracy, from switching on the 20 MW power converter (so that one of the 20 MW resistive magnets or the insert of the hybrid magnet system can begin to be energized) to the stop command (when the installation will return to its safe and off-state); the different instances of use will be summed to half hour precision to establish the share in use of the installation.

The major direct cost item is the cost of electrical power (both kW and kWh) and maintenance of the plant and coils, in addition considerable costs are made for the cryogenic liquids for user experiments (and hybrid magnet). The requested unit fee also covers a small fraction of the personnel costs of technical and scientific support.


Distribution of proposals per country (HFML: 2003-2008)
USA
United Kingdom
13
Ukraine
Switzerland
Spain
7
South Africa
Russia
Portugal
Poland
Netherlands
132
Moldavia
Japan
Italy
7
Israel
11
Greece
Germany
32
France
Estonia
Belgium
Austria
0
20
40
60
80
100
120
140

Work package number	WP 6	**Start date or starting event:**			M1
Work package title	**Transnational access pulsed fields FZD**				
Activity Type	SUPP				
Beneficiary number	3				
Beneficiary short name	FZD				
Person-months per beneficiary: (permanent staff:)	6 (6)				

Description of the infrastructure
<u>Name of the infrastructure:</u> *Hochfeld-Magnetlabor Dresden*
<u>Location (town, country):</u> *Dresden, Germany*
<u>Web site address:</u> *http://www.fzd.de/hld*
<u>Legal name of organisation operating the infrastructure:</u> *Forschungszentrum Dresden-Rossendorf*
<u>Location of organisation (town, country):</u> Dresden, Germany
<u>Annual operating costs (excl. investment costs) of the infrastructure (€):</u> 3,5 M€

<u>Description of the infrastructure</u>:

The Hochfeld-Magnetlabor Dresden (HLD) is operated by the FZD as one of the four large European user facilities for experiments in high magnetic fields. Starting from 2007, the HLD has opened its doors as a user facility for national and international users. At the HLD, pulsed magnets are available ranging from 55 T/20 ms/20 mm for maximum field, pulse duration and bore diameter to 70 T/150 ms/24 mm. One long pulse magnet with the features 60 T/1000 ms/24 mm will be put into operation in 2008. Most challenging, a two-coil magnet system for the generation of fields up to 100 T is also continuously tested and stepwise improved by partly replacing its components. At the end of 2007, HLD has produced its maximum field of 78 T so far. The energy for the magnets is provided by a modular 50 MJ/5 GW capacitor bank, the largest one of its kind in the world. The bank can be switched between 5 magnet sites. In-house research at the HLD focuses on electronically correlated materials in high magnetic fields. In particular, electronic properties of metallic, semiconducting, superconducting, and magnetic materials are investigated. Work is being carried out on exotic superconductors, strongly correlated systems, low-dimensional magnetic materials as well as nanostructures on inorganic and organic templates.

Unique in the world, the free-electron laser facility (FELBE) of the neighbouring superconducting electron accelerator ELBE allows high-brilliance radiation to be fed into the pulsed-field chambers of the HLD, thus making possible high-field magneto optical experiments in the mid and far infrared, 4-230 µm. Indeed, very recently the first successful detection of an ESR signal at 44 T by use of the FELBE radiation at about 230 µm in a pulsed magnet was achieved. This unique technique will now be made available for the users. Cryogenic infrastructure (^{4}He- and ^{3}He cryostats) as well as a variety of experimental setups (electrical transport, magnetization, photoluminescence, visible and infrared spectroscopy, ultrasound, etc.) can be offered to the users. The HLD is also engaged in the development of novel experimental techniques including resonant methods as ESR and NMR each modified for the use in high pulsed magnetic fields. For the continuous upgrade of the HLD, a development program for pulsed magnets and pulsed power supplies is being carried out which makes also use of modern simulation methods based on finite elements.

Description of work

Modality of access under this project: *Common procedure for all TNA WP, see WP2, Task 3.*

Support offered under this project:

The HLD offers full access to its high field installation and all the scientific equipment associated with it to all qualified users. Its scientific, technical and administrative staff will support the user in preparing, executing and evaluating experiments and with travel and housing arrangements. The HLD has top-class instrumentation for pulsed field experiments. Many of the HLD staff members are leading experts in their field and have already some experience in supporting user experiments.

Outreach of new users: *Common procedure for all TNA WP, see WP2, Task 3*

In addition, the Dresden High Magnetic Field Laboratory (HLD) is engaged in many collaborations with several partner institutes within Dresden (two Max Planck and two Leibniz institutes as well as the Dresden University of Technology) and with many other European research institutes from the high field as well as from the solid-state physics science community. The FZD is also a member of the International Institute of Complex and Adaptive Matter (ICAM-I2CAM) and has cooperation with partners from all over the world. In July 2009, HLD organizes the next Research in High Magnetic Fields (RHMF 2009) conference in Dresden as a satellite of the International Conference in Magnetism (ICM 2009), to be held in Karlsruhe. Due to these many contacts and cooperation from all over Europe and beyond, the HLD has good conditions to attract more and more users in a relatively short time after its opening as user facility in 2007.

Review procedure under this project: *Common procedure for all TNA WP, see WP2, Task 3*

Implementation plan

Short name of installation	*Unit of access*	*Unit cost*	*Min. quantity of access to be provided*	*Estimated number TNA users*	*Estimated number of TNA days spent at the infrastructure*	*Estimated number of TNA projects*
HLD	Magnet pulse	400 €	750	70	500	50

Unit of Access:

The unit of access is a magnetic field pulse. Apart from the direct running costs of the installation, and the depreciation of the coils (pulsed field coils have a finite lifetime and should be considered as consumables), this includes all additional costs necessary to realize the experiment during the pulse including but not limited to cryogenic liquids, use of all laboratory facilities and workshops, use of all electronic equipment and computer facilities and support by the local scientific, technical and administrative staff, in preparation, execution and evaluation of the experiment. The user will receive training in the operation of the installation and its security aspects.

Work package number	WP 7	**Start date or starting event**:		M1		
Work package title	**High Field User Magnet Technology and Operation**					
Activity Type	RTD					
Beneficiary number	1	1	2	3		
Beneficiary short name	CNRS GHMFL	CNRS LNCMP	RU	FZD		
Person-months per beneficiary: (permanent staff:)	120 (66)	92 (56)	34 (16)	60 (30)		

Objectives

The impact of magnetic fields on science is mainly due to the availability of the highest magnetic fields to a large scientific community. High field magnet development and operation requires sophisticated knowledge in materials science, mechanical and electrical engineering as well as in advanced modelling and simulation. JRA WP7 aims to improve significantly the performance, reliability, versatility, and user friendliness of the magnets at the four high field infrastructures. Its implementation will take into account the specific features of DC and pulsed facilities but collaborative approaches will be realized wherever possible. The improved usefulness will be realized by improving the field quality and by constructing special purpose user magnets. The results of this work package will benefit the general user community, and also more concretely the WP 9 ‘ES^3-NMR’ and WP8 ‘Nano-object measurements’ described below.

At present, engineers and scientists of all four European high field facilities have developed, so far largely independently, highly-specialized expertise in magnet- and power supply technology, which has resulted in world leading infrastructures for DC and pulsed magnetic fields. A **joint inventory** of the available knowledge and **benchmarking** of the different design and construction technologies and a common technical **data base** will allow producing even better magnets.

Materials development lies often at the heart of improvements in **user magnet performance**. Pulsed magnets require high-strength and hence low conductivity materials, whereas DC magnets require high-conductivity materials, with lower strength. However, the increased use of distributed reinforcement in pulsed-field coils has increased the demand for medium strength conductors combining high conductivity, high plastic deformation and high fatigue-life. These materials are also interesting for DC fields. Moreover the metallurgic know-how and testing equipment are similar for the conductors of DC or pulsed magnets and could benefit from the synergy.

An important functionality of all types of magnets, both DC and pulsed, is **cooling**, which has so far received little attention. The heat transfer coefficient from the conductor to the coolant depends critically e.g. on the surface structure. The room for improvement of the effectiveness of this heat transfer has so far not been systematically explored and this exploration will be an important activity within this task.

Another important aspect of the performance of high field facilities is the **stability** and **noise reduction**. The present 20 MW DC installations can provide a current stability of the order of 10 ppm. However, field stability is still above this level and needs to be improved for certain applications, in particular for the activities within WP 9 ‘ES^3-NMR’. Similarly, the noise level in pulsed field installations complicates certain high-sensitivity experiments (e.g. the WP8 Nano-object measurements) and should be reduced.

There is a growing demand for **special purpose magnets** at the infrastructures. **Radial access** to DC magnetic fields is required for many spectroscopic experiments including optics, X-rays and neutrons. Currently the only DC resistive magnet with radial access is located at GHMFL. The only pulsed coil with radial access is in operation at the Japanese synchrotron Spring-8. Therefore both pulsed and DC radial access magnets will be developed in this JRA. Sharing of expertise and joint development between DC and pulsed facilities will permit an efficient design and construction of

such special purpose magnets.
To realize all the objectives of this WP, the work is organized in three technical tasks, plus one management task, as described below.

Description of work

Task 1: Inventory & benchmarking of magnet technology at the infrastructures (CNRS, FZD, RU)

The first task will be to extend the technical database implemented in the pulsed field FP6 DS-DeNUF project, and maintained by FZD-HLD, to DC fields. All existing material data (conductors, insulation materials and reinforcement materials), vendors, design techniques will be added by GHMFL and HFML and the entire database will be available to all the partners. Where required, additional materials (conductors, composites and fibres) for use in DC as well as in pulsed magnets will be tested using the existing know-how and the test equipment available at the HFML and the LNCMP. In the same perspective, to take maximum advantage of the existing design methods and principles we will make an inventory of existing designs and design methods and we will organise round-table discussions to list and categorize modern design methods.

Next, a critical assessment of design methods and principles will be made by benchmarking magnet designs both for DC and for pulsed magnets. Experience and know-how in electro-mechanical and thermal simulation (finite element calculations) will be shared and critically assessed. Pulsed field simulations are traditionally focused on the highest stresses under plastic deformation, whereas DC field magnets need to cope with moderate peak stresses and temperature distribution and lifetime issues. Combination of expertise may improve the lifetime of pulsed-field coils and/or increase the maximal acceptable stresses in DC field coils and thereby the maximum field. We will organise workshops with specialists in the all the fields pertaining to magnet design: mechanics, metallurgy and thermo-hydraulics.

Task 2: Improved user magnet performance (CNRS, FZD, RU)

In this task, the infrastructures will focus on several aspects of their magnetic field quality in order to increase the usefulness and effectiveness of their installations for the users. First, the DC magnet heat transfer by water cooling will be studied. Improvements will be sought by controlling surface roughness and applying special surface coatings. We will study experimentally cooling in Bitter-type (HFML) and polyhelix-type (GHMFL) model magnets, by measuring heat transfer coefficients as a function of wall roughness, material, water velocity, additives, temperature etc. and will develop the necessary common theoretical description. Improved cooling efficiency should allow for higher fields, and in addition, colder magnets have lower power consumption and longer lifetimes and therefore have a better and more reliable availability for the users. If possible, these results will be translated to liquid nitrogen cooling as used in pulsed magnets with the aim to reduce the cool-down time between magnet pulses. Within this activity the partners will collaborate with the 'Laboratoire des Ecoulements Géophysiques et Industriels' (LEGI) a Grenoble based laboratory specialized in research on fluids. If this study suggests very large possible increases in cooling efficiency, these will be first implemented and tested in a real scale coil and if successful, later on in the user coils. If this study suggests only modest possible improvements, then these would be gradually introduced into the user coils that will be constructed within the normal coil program of the infrastructures.

In order to improve the field stability and to reduce field noise the DC laboratories will identify the main options available, like NMR feedback on the main power supplies and flux compensation for Bitter, PolyHelix and Hybrid magnet operation.

The partners will first explore and model the relevant magnet, cooling system and power converter parameters for improved field quality. Then the most effective modifications will be tested and

implemented in both DC facilities. Both DC field laboratories will provide fields with 10 ppm temporal stability that will be at the disposal of the user community.
In order to reduce the electro-mechanical noise level in pulsed field installations HLD and LNCMP will follow two strategies. First, a systematic comparison of the noise in various types of pulsed field coils at HLD and LNCMP will allow to better determine the origins of this problem. This will allow to improve the design strategies and coil construction technologies in order to arrive at lower field noise levels. Secondly HLD and LNCMP will jointly investigate, develop and implement electro-magnetic filtering techniques to reduce the remaining field noise at the sample position. These two strategies should result in significantly better signal to noise ratios for experiments, of which WP8 and WP9 will be the first to profit, but which will serve the entire user community.

Task 3: Special purpose magnets (CNRS, FZD, RU)
The main aim of this task is to design, construct and test special user magnets that can be put at the disposal of the user community. This task will already profit from the results of the first two tasks, making an optimal materials choice using the database created by task 1 and possibly profiting from low-noise and efficient cooling approaches developed in task 2. After consultation of the user community we have chosen to construct a DC radial access insert magnet and a pulsed radial access magnet. These coils will allow new types of experiments at the infrastructures, and will open a significant scientific potential for the user community.
First, a radial access DC insert magnet for optical experiments will be designed, constructed and tested in an existing magnet housing. The target field for this coil will be 20 T, as compared to the highest existing radial access resistive field of 14 T, at the GHMFL. Radial access sub-coils, Bitter type as well as polyhelix-type will be produced and tested together in one DC magnet. This magnet will evidently profit from the results of tasks 1 and 2. This prototype can serve as a 12 MW radial access user magnet if the additional funding for the housing can be found. If this magnet creates sufficient user operation, in a later stage, it will be combined with radial access outer coils into a 24 MW radial access magnet producing 25-30 T.
Secondly, radial access pulsed magnets will be designed, constructed and tested in a joint effort by HLD and LNCMP. Different geometrical configurations will be considered for these magnets with one or two sub-coils. The crucial point in this design is to get a high duty cycle (20 ms above 35 T, cool down time 100 s) as it will mainly be used in combination with a free electron laser (HLD), or X-ray sources (LNCMP) which have only a limited availability. The design parameters (like magnet bore, pulse duration, peak field, geometry of optical access) will be based on the experience, obtained at the LNCMP with synchrotron radiation experiments using pulsed magnetic fields with standard longitudinal access coils. A first coil will be designed and constructed for X-ray scattering (installation at LNCMP), and learning from the performance obtained, a second, improved coil will be designed for FEL experiments at HLD.

Task 4: Management
The WP7 task leader will organize the 6 month reporting to the Coordinator and the management of the WP7 task. The partners will actively establish close contact and collaboration with the different user groups of the high field infrastructures in order to obtain additional input and feedback on coil performance and promote the dissemination of their results at conferences and in publications.

Del. no.	Deliverable name	Nature	Dissemi-nation level	Beneficiaries	Delivery date
D7.1.1	Extended database	O	CO	all	M12
D7.1.2	Inventory and benchmarking methods	R	CO	all	M12
D7.2.1	Heat transfer studies	R	PU	all	M36
D7.2.2	Magnet and power converter test measurements, modelling and analysis	R	PU	GHMFL, HFML	M12
D7.2.3	Improved field stabilization system for user experiments	D	PU	GHMFL, HFML	M18
D7.2.4	Noise reduction in pulsed magnets	R	PU	FZD, LNCMP	M24
D7.3.1	Design, construction and testing of a 12 MW DC radial access insert coil	D	PU	GHMFL, HFML	M48
D7.3.2	Design, construction and testing of pulsed radial access coils	D	PU	FZD, LNCMP	M36
D7.4.1	Periodic task progress reports	R	CO	all	M6,M12, …M48

Work package number	WP 8	**Start date or starting event:**		M1	
Work package title	**Nano object measurements and local spectroscopy**				
Activity Type	RDT				
Beneficiary number	2	1	1	3	5
Beneficiary ID	RU HFML	CNRS LNCMP	CNRS GHMFL	FZD	UOX-DK
Person-months per beneficiary: **(permanent staff:)**	49 (13)	45 (9)	45 (9)	28 (4)	45 (9)

Objectives

An important trend in modern science is the investigation of smaller and smaller structures with properties determined by a nano-sized group of atoms or molecules. Examples are semiconductor quantum dots, organic nanostructures and carbon-based systems like nanotubes and graphene. To unravel their electrical, optical and magnetic properties it is crucial to measure the response of *individual* nanostructures, in particular for those cases where experiments on an ensemble of objects conceal important properties or processes. In ensemble measurements only the *average* value of an observable parameter is detected, and limited information is obtained about the contribution of individual objects to the overall process. For instance, temporal information about dynamical processes might get lost by ensemble averaging, as well as spectroscopic information when the averaging occurs over objects that are not precisely identical.

In recent years significant progress has been made in the development of scanning probe techniques or other single-object or local-spectroscopy methods, and some of them have been implemented in commercially available superconducting magnets (<12 T). There is an increasing demand from the high field community to extend local probe and single-object measurements up to the highest magnetic fields, to benefit from the powerful combination of nanoscience and high fields. At those fields the magnetic length (4 nm at 40 T) becomes comparable to typical dimensions of nano-objects, leading eg. to significant changes in their energy spectrum, allowing advanced magneto-spectroscopy experiments.

The objective of this JRA is to develop new experimental techniques in very high magnetic fields to determine the properties of *individual nanostructures* and/or to perform *local* spectroscopy. A complementary set of 4 advanced experimental (both electrical and optical) techniques is planned, formulated by the following tasks:

- T 8.1 Electrical transport on individual nano-objects in pulsed fields
- T 8.2 Single-object photoconductivity in DC and pulsed fields.
- T 8.3 Time-resolved Photon-Correlation spectroscopy in DC fields.
- T 8.4 Photoluminescence and Magneto-Optical-Kerr-Effect imaging in DC fields.

The implementation of such advanced instrumentation in a high-field environment is a formidable challenge. First of all, the measurement signals are very small, i.e. down to the single-photon level for the optical experiments, and down to pico-ampere current levels for the electrical measurements, which should be realized in magnet coils that draw currents in excess of 10 kilo-ampere! Secondly, these experimental techniques need a very precise and stable nano-scale positioning, which implies that mechanical vibrations should be reduced to the absolute minimum. Finally, nano-scale samples are extremely delicate to handle and can easily be damaged by current spikes in the circuit, for instance upon switching large capacitor banks or power converters. This type of experiments is however feasible now, combining the present high performance level of the high magnetic field installations and the specialised expertise of internal and external user groups.

A common task will be the development of experimental protocols how to reliably perform single nano-object experiments. This will include procedures for operating the magnet current-sources and protecting fragile samples, for proper shielding the measurement circuitry, for using high-field compatible piezo-nanopositioners, and for minimizing mechanical vibrations by using active-feedback mounting of Helium cryostats. The performance of the new electrical and optical equipment will be demonstrated using a set of nano-objects consisting of semiconductor quantum dots (epitaxial and colloidal), carbon nanotubes and graphene flakes. If necessary the tests will be performed at the different facilities, which is possible because all dimensions of the new experimental tools will be standardized.
In all tasks specialized external user groups are actively involved in the development and testing of the equipment, which ensures that all requirements of the user community will be fulfilled. Upon completion the new set-ups will become available for all interested user groups.

Description of work

JRA Coordination: P.C.M. Christianen (RU-HFML).
Preparation of reports, dissemination of information by maintaining the JRA home page. Twice a year a meeting will be organized to exchange problems and solutions and to discuss the results and further plans.

Task 8.1 Electrical transport on individual nano-objects in pulsed fields *phd student, postdoc*
Task leader: B. Raquet (LNCMP), collaborators: LNCMP, FZD, UOX-DK, RU-HFML
The goal is to develop a safe (for the sample) and accurate low-temperature experimental set-up to measure transport properties of very fragile individual nano-objects in pulsed magnetic fields. The aggressive and noisy environment inherent to a pulsed field installation requires specific adaptations. It includes special shielding and procedures to charge the capacitor bank, filters and connections on a rotating sample holder under controlled atmosphere that permits in-situ annealing. The design and fabrication of the set-up will occur within a close collaboration of LNCMP and FZD. It will be tested with measurements on carbon nanotubes and graphene in collaboration with UOX-DK and RU-HFML. The set-up and the measurement protocols will serve as the basis for the electrical part of the photo-conductivity equipment of task 8.2.

Task 8.2 Single-object photoconductivity *phd student*
Task leader: R. Nicholas (UOX-DK), collaborators: UOX-DK, LNCMP, FZD, GHMFL
The task is to develop new measurement systems that combine optical and electrical experiments by measuring the photoconductivity of individual nano-objects in DC and pulsed magnetic fields. The project will explore both the visible/near infrared and THz regions of the spectrum, requiring the development of both optical fibre and waveguide approaches. The optical/nir part of the experimental set-up will be designed and built by the user group at UOX-DK, which has considerable experience in performing nanotube experiments at low magnetic fields. Since the design has to be compatible with the specific pulsed magnetic field environment, this task will be achieved within a close collaboration with the LNCMP phd student and FZD postdoc of task 8.1. The visible/nir apparatus will be tested and used in the DC fields at GHMFL and pulsed fields at LNCMP by pilot experiments on carbon nanotubes, graphene and semiconductor quantum dots.

Task 8.3 Time-resolved Photon-Correlation *phd student*
Task leader: M. Potemski (GHMFL), collaborators: GHMFL, RU-HFML, UOX-DK, Warsaw
Time-resolved Photon Correlation (TPC) measurement is a widely applied technique that permits to identify the unique dynamical properties of individual objects. Photon correlation experiments in high magnetic fields are not as yet available but will certainly enrich the experimentation potential to study various nanostructures such as semiconductor dots or carbon nanotubes. The objective of this project is the construction of a high–field photon correlation insert. This will be the main task

of the GHMFL group, in collaboration with RU-HFML and the user group from Warsaw. This latter group has already developed a photon correlation set-up, but is interested in using the technique at high magnetic fields and offers their expertise in developing it. The whole set-up for photon correlation experiments will consist of heavy equipment (pulsed laser) coupled (via optical fibers) to a specially designed optical insert, eventually immersed in liquid Helium for experimentation at low temperatures and an optical bench composed of two monochromators (equipped with avalanche photodiodes, CCD camera and fast electronics). The costs of the elements of the external part of the set-up will be covered by the running budget of the Grenoble lab. Man power will be covered by this project.

Task 8.4 Photoluminescence and Magneto-Optical-Kerr-Effect imaging *phd student*

Task leader: P.C.M. Christianen (RU-HFML), collaborators: RU-HFML, GHMFL, Dortmund

This project is aimed at the development of a wide-view optical microscopy set-up in DC fields up to 33 T. The fiber-free optical design follows the lay-out of photoluminescence (PL) imaging set-up that currently operates up to 12 T in a superconducting magnet. It allows making real-space, diffraction-limited optical images of the sample on a sensitive CCD camera in a single exposure. This approach is complementary to the fiber-based set-up at the Grenoble facility and can also be combined with photon correlation (8.3) experiments. One of the main advantages of this approach is that the laser excitation and PL detection volumes can be spatially separated which allows for optically probed transport experiments. Furthermore, since all polarization optics is situated outside the magnet, full control of the different spin-detection schemes can be obtained. This method thus permits to study the spin properties of spatial patterns of exciton condensates and optically-detected spin transport in semiconductor nanostructures, both with photoluminescence and Magneto-Optical Kerr-Effect (MOKE) experiments. This latter method is initiated by the collaborating group from Dortmund University that has a large experience in this area and which offers their expertise to implement MOKE detection schemes at high magnetic fields.

List of people involved:

Bertrand Raquet, Michel Goiran, Walter Escoffier (LNCMP, Toulouse)
Marek Potemski, Duncan Maude (GHMFL, Grenoble)
Manfred Helm, Yurii Skourskii, Oleksiy Drachenko (FZD, Dresden)
Peter Christianen, Uli Zeitler (RU-HFML, RU Nijmegen)
Robin Nicholas (user group UOX-DK, Oxford University)
Roman Stepniewski, Piotr Kossacki (user group Warsaw University)
Manfred Bayer, Dmitrii Yakovlev (user group Dortmund University)

WP 8 Nano object measurements and local spectroscopy				
Del. no.	**Deliverable name**	**Type**	**Diss Lev.**	**Date**
D 8.1.1	Characterization of noise & current spikes during bank discharge	R	PP	M6
D 8.1.2	Insert for single nano-object transport up to 70 T	P	PP	M12
D 8.1.3	Testing equipment/software for ultra-low noise & fast data acquisition	R	PP	M18
D 8.1.4	Implementation of nano-object magneto-conductivity set-up in pulsed magnets	D	PU	M24
D 8.2.1	Test and refine deposition procedures to enable photo-conductivity measurements on single nanotubes and graphene flakes	R	PP	M12
D 8.2.2	Single-object photoconductivity insert	P	PP	M18
D 8.2.3	Implementation nano-object photoconductivity equipment in DC magnet	D	PU	M24
D 8.2.4	Implementation nano-object photoconductivity equipment in pulsed magnet	D	PU	M36
D 8.3.1	Time-resolved Photon-Correlation (TPC) insert	P	PP	M18
D 8.3.2	Test and optimization of optical part of TPC apparatus	R	PP	M24
D 8.3.3	Implementation of TPC equipment in DC magnet	D	PU	M30
D 8.4.1	Optical imaging insert for 32 mm bore 33 T magnet	P	PU	M18
D 8.4.2	Testing Magneto-Optical Kerr-Effect (MOKE) detection scheme up to 33 T	R	PP	M30
D 8.4.3	Set-up for PL and MOKE imaging up to 33 T	D	PU	M36
D 8.4.4	Final report on optical imaging experiments of semiconductor nanostructures	R	PP	M48
D 8.1-4	Periodic reports, meetings and dissemination	R	PP	M18, 30, 48

Milestone number	Milestone name	Date	Means of verification
M 8.1.1	User experiment: magneto-conductivity of single carbon nanotubes in pulsed fields	M24	Report, decision to proceed with pulsed field photo-conductivity
M 8.3.1	Pilot luminescence experiment single semiconductor quantum dot with TPC apparatus	M24	Report, decision to proceed with implementation of TPC modules
M 8.4.1	Pilot experiment optical imaging apparatus – excite and detect at different positions	M24	Publication(s), report, decision to proceed with polarized PL and MOKE detection schemes

Work package number	WP 9	**Start date or starting event:**				M1
Work package title	**Enhanced Sensitivity and Single Scan NMR (ES^3-NMR)**					
Activity Type	RTD					

Beneficiary number	1	1	2	3	4	6	7
Beneficiary short name	CNRS LNCMP	CNRS GHMFL	RU NMR	FZD	ULEI	TUT	WI
Person-months per beneficiary:(permanent staff:)	32 (18)	42 (24)	48 (24)	24 (12)	18 (6)	14 (6)	16 (6)

Objectives:

At present, the main incentive driving the progress beyond the state of the art in high field NMR research is the study of exotic states of matter in physics such as field driven quantum phase transitions. In chemistry and materials research, it is the substantial resolution enhancement that can be obtained for most quadrupolar nuclei. At very high magnetic fields the relative spectral linewidth decreases making the NMR spectrum easier to measure and to analyse. For nuclei with strong quadrupolar couplings the spectral line width scales with B^{-1} and the resolution improves with B^2. In the case of relatively small quadrupolar couplings the high field spectra converge towards an isotropic limit. Structural biology and biochemistry will probably remain in the realm of high resolution superconducting instrumentation. However, there are examples where the combination of high magnetic field and very fast magic-angle spinning NMR on bio solids may give unique information on for example hydrogen bonding problems. In many cases it is important to measure interactions between different nuclei (sites) so that 2D experiments are imperative, allowing all advanced pulse sequences that are developed in the wider NMR community. At present, this fairly large community has not found its way towards the high magnetic field facilities. It is the ambition of this JRA to establish new and affordable opportunities for NMR at fields far beyond the commercially available range.

Establishing NMR in pulsed magnetic fields up to 60 T and beyond will lead to a dramatic expansion of the accessible field range which will be most relevant for the study of field induced (quantum) phase transitions. An example of this is the study of the low temperature field induced normal state of high T_c superconductors. Other condensed matter systems and phenomena where very high field NMR could potentially provide valuable information, are: quantum critical points in heavy fermion systems, field induced superconductivity (Jaccarino-Peter effect), magnetic ordering of low dimensional organic magnets, Fulde-Ferrel-Larkin-Ovchinnikov superconductivity, field induced closing of the energy gap in Kondo insulators, Lifshits quantum-phase transition, field induced Bose-Einstein condensation of magnons in singlet-triplet systems, etc. As the nuclear magnetization needs to build up during the field pulse, this research may benefit substantially from the longer pulse durations available in the Toulouse (LNCMP) and Dresden (FZD) facilities.

In EuroMagNET I it was demonstrated that high field solid state NMR in resistive magnets is feasible without compromises in terms of resolution and flexibility, including advanced multi-dimensional pulse sequences. Since extensive averaging leads to unacceptable energy consumption and financial costs we intend to develop and implement as a user facility various methods to improve the NMR signal to noise ratio. Partly this will consist of modifications in the high field installation to reduce the field fluctuations. The NMR detection probes will be optimized to have the highest coupling, the highest excitation bandwidth and the lowest noise. A major project will focus on the development and implementation of hyper polarization techniques in resistive magnets. Pulsed field NMR is in its infancy, and although the proof of principle was achieved, none of the principal components of a pulsed field NMR installation (probe-head, magnet, power supply) have been fully optimized for this application. The development of these components will be a major challenge and objective of WP 9. In collaboration with user groups we will explore and exploit the potential of pulsed field NMR to address fundamental problems in materials research. All methods and instrumentation developed in this work package will become available to external users of the four European high field facilities in this collaboration.

Description of work

Task 1: Cryogenic probe heads for pulsed field solid state NMR (LNCMP, ULEI, FZD)

Due to the limited signal averaging possibilities in pulsed field NMR, an efficient cryogenic NMR-probe head is indispensable. The main source of electric noise, the NMR pick-up coil resistance, will be minimized by the use of cryogenically cooled detection coils, developed at ULEI and a matched low-noise cryogenic preamplifier, developed at LNCMP. The probe heads will be optimized to study small solid state samples (1 mm^3 or smaller) at temperatures down to 1.8 K. The final results of this task will be made available for user operation at LNCMP and HLD.

Task 2: Design and optimization of pulsed NMR magnet setup (FZD, LNCMP)

The pulsed field facilities in Dresden and Toulouse will together design and construct an optimized pulsed field NMR setup suitable for solid state nuclear magnetic resonance.

Task 3: NMR experiments in pulsed magnetic fields (ULEI , FZD, LNCMP)

The instrumentation developed in tasks 1 and 2 will be used to perform pioneering and advanced NMR experiments, first to check and demonstrate the operability of the spectrometer components, later to focus more on outstanding phenomena in solid state physics using the NMR technique in high pulsed magnetic fields. This will help to create a user community for this new technique.

Task 4: Sensitivity optimized NMR instrumentation for DC fields (GHMFL, LNCMP)

Based on its experience as a high field NMR user facility in condensed matter physics the GHFML will develop tailored NMR instrumentation for enhanced resolution, field stability and optimized sensitivity in the field range up to 32 T and will place it at the disposal of the user groups. This activity will provide new options for the solid state physics community, since the increased sensitivity will allow for otherwise prohibitively time consuming measurements. Also, this extension will meet the particular demands of new user groups coming from the area of materials-related research and solid state chemistry. One of their main interests is the high field spectroscopy of low-sensitivity quadrupolar nuclei. We intend to obtain maximum compatibility with commercial NMR instruments (sample dimensions, pulse sequences etc.). Both static and MAS broadband tunable NMR probeheads for Larmor frequencies up to 500 MHz will be developed and assembled that cover all interesting quadrupolar nuclei up to 32 T. The coil diameter will be fixed to 3-5 mm and special attention will be paid to obtain strong H_1 fields (> 250 kHz) for broader excitation bandwidth. The design of the probeheads will integrate passive shim elements for field homogenization as well as active NMR and fluxgate feedback circuits that will compensate field fluctuations. For low-γ nuclei an improved homogeneity together with a dedicated NMR probehead will allow “standard” sample sizes and reasonable acquisition times. The aimed temporal field stability will be better than 10 ppm and will enable the application of sensitivity enhancing NMR pulse sequences like QCPMG. The resolution will be: 50 ppm static, with spin lock and homogenization 5 ppm or better and finally, with the homogeneous magnet 1 ppm or better. For enhanced sensitivity of solid state NMR in condensed matter cryogenic preamplifiers (see task 1) and other electronic components working at low temperatures will be implemented, in collaboration with task 1. These components will be directly installed inside the main cryostat.

Task 5: Dynamic Nuclear Polarization (DNP) at high magnetic fields (RU-NMR, FZD, ULEI)
Extensive averaging in resistive magnets is a costly process. Dynamic Nuclear Polarization involves the transfer of the much larger electronic magnetization from unpaired electrons to the surrounding nuclei using various modes of microwave irradiation at or near the EPR transition. DNP at very high fields requires a high power source in the Terahertz range. As a first step we will built and optimize a low temperature probe for polarization at 95 GHz. The methodology will be tested in low field superconducting magnets. If additional funding becomes available, we will implement the same method in the high field Bitter magnets, using either a fast field sweep (10 sec) or new high frequency sources.

Task 6: Single scan multi dimensional NMR (WI, RU-NMR)
Multiple dimension NMR spectra are usually rather time consuming. In superconducting magnets this is not critical and experiments are running 24 hours a day under full computer control. However, if there is an excellent SNR in a single scan one can use encoding in a spatial dimension or exploit the different orientations in powder samples to obtain full 2D data. In principle one can use the same procedure to deal with static magnetic field inhomogeneities along the sample axis. As a first step in this direction, we will built a probe to include fast switching gradients with efficient microstripline NMR detection. The spectrometer will be modified to allow single scan 2D operation. The method will be tested in fields up to 20 T. Implementation in the high field magnets will depend on the future funding situation.

Task 7: Low temperature µMAS, DNP and high magnetic fields (RU-NMR, TUT)
Microcoils down to about 100 micron in diameter are now used in combination with magic angle spinning. An obvious advantage is that one can hope to achieve a better ultimate resolution in inhomogeneous field profiles. We will implement in situ electrical shim coils to compensate remaining field gradients along the spinning axis. The improved excitation efficiency of these coils allows a very broad spectral range of up to 5 MHz which can be quite relevant to for wide line NMR systems and can avoid cumbersome and time consuming frequency stepped data acquisition methods. The superior detection sensitivity partly compensates for the reduction in sample volume. Very broad quadrupolar spectral distributions are condensed in high magnetic fields and more favorable Boltzmann factors at high fields and low temperatures may help to improve fast acquisition. A special option can be the spinning of small (nano)crystals where the sensitivity is greatly enhanced since spectral intensity is condensed in discrete spinning sidebands, while preserving information on chemical shift or quadrupolar anisotropy. A second advantage of the microMAS concept is that the sample can be cooled independently from the MAS rotor, greatly reducing the mechanical and dynamical problems of low temperature turbine and bearing operation. The probe will be tested and optimized in a superconducting 20 T NMR magnet.

Task 8: Coordination, reporting and dissemination (RU-NMR)

The partners in this JRA will meet on an annual basis to discuss the progress, exchange problems and solutions and forge new collaborations with user groups to implement new options and improvement for a more versatile and efficient use of the high field facilities. Results and opportunities will be actively promoted at conferences. The coordinator will organize the yearly reporting and management.

Deliverables:

Deliverable	Title	Responsible Partner(s)	Month
D9.1	Implementation of pulsed field NMR setup including cryogenic 1 GHz probehead, open for users	LNCMP, ULEI, FZD	M36
D9.2	Pulsed magnetic field NMR experiments on an out-standing phenomenon (e.g. high Tc superconductivity or quantum phase transition)	LNCMP, FZD, ULEI	M42
D9.3	Final report, pulsed magnetic field spectroscopy	ULEI, FZD, LNCMP	M48
D9.4.1	Advanced DC NMR probes comprising shim and field stabilization units	GHFML, RU-NMR	M30
D9.4.2	Cryogenic electronics for low temperature NMR	GHFML, LNCMP	M36
D9.4.3	Final report on user experiments with enhanced sensitivity	GHFML	M48
D9.5	DNP probe with 95 GHz resonator	RU-NMR	M24
D9.6.1	Static NMR stripline probe with integrated gradient coils.	RU-NMR	M24
D9.6.2	Methodology and proof of principle for single scan 2D NMR in superconducting magnets.	WI, RU-NMR	M36
D9.7.1	Micro MAS probe tested up to 20 T	RU-NMR	M24
D9.7.2	Feasibility study for Low temperature options and DNP implementation	RU-NMR	M48
D9.8.1-4	Periodic reports, meetings and dissemination	RU-NMR	M18, 30, 48

B.1.3.6 Efforts for the full duration of the project

Project number (acronym) : *228043 (EuroMagNETII)*

Work package	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	**TOTAL**
1 LNCMP	**36**	8	0	**8**	0	0	92	45	32	221
1 GHFML	6	8	**8**	0	0	0	**120**	45	42	229
2 RU	6	10	0	0	8	0	34	**49**	**48**	155
3 FZD	6	24	0	0	0	6	60	28	24	148
4 ULEI	0	0	0	0	0	0	0	0	18	18
5 UOX-DK	0	8	0	0	0	0	0	45	0	53
6 TUT	0	0	0	0	0	0	0	0	14	14
7 WI	0	0	0	0	0	0	0	0	16	16
TOTAL	54	58	8	8	8	6	306	212	194	854

Project number (acronym) : *228043 (EuroMagNETII)*

Activity Type	CNRS LNCMP	CNRS GHMFL	RU	FZD	ULEI	UOX-DK	TUT	WI	TOTAL ACTIVITIES
RTD									
WP 7	92	120	34	60	0	0	0	0	306
WP 8	45	45	49	28	0	45	0	0	212
WP 9	32	42	48	24	18	0	14	16	194
Total 'RTD'	169	207	131	112	18	45	14	16	712
COORD									
WP 2	8	8	10	24	0	8	0	0	58
Total 'COOR'	8	8	10	24	0	8	0	0	58
Consortium management activities: MGT									
WP 1	36	6	6	6	0	0	0	0	54
Total 'MGT'	36	6	6	6	0	0	0	0	54
SUPP									
WP 3	0	8	0	0	0	0	0	0	8
WP 4	8	0	0	0	0	0	0	0	8
WP 5	0	0	8	0	0	0	0	0	8
WP 6	0	0	0	6	0	0	0	0	6
Total 'SUPP'	8	8	8	6	0	0	0	0	14
TOTAL BENEFICIARIES	223	219	153	136	18	49	14	16	854

Implementation plan Transnational Acces

Short name of installation	Unit of access	Unit cost	Min. quantity of access to be provided	Estimated number of users	Estimated number of days spent at the infrastructure	Estimated number of projects
GHMFL	Magnet hour	900 €	2400	250	1200	200
LNCMP	Magnet shot	400 €	1600	150	1000	100
HFML	Magnet hour	900 €	1200	90	900	60
HLD	Magnet shot	400 €	750	70	500	50

Unit of Access:

Pulsed fields: The unit of access is a magnetic field pulse. Apart from the direct running costs of the installation, and the depreciation of the coils (pulsed field coils have a finite lifetime and should be considered as consumables), this includes all additional costs necessary to realize the experiment during the shot including but not limited to cryogenic liquids, use of all laboratory facilities and workshops, use of all electronic equipment and computer facilities and support by the local scientific, technical and administrative staff, in preparation, execution and evaluation of the experiment. The user will receive training in the operation of the installation and its security aspects.

DC fields: The unit of access is a magnet-hour, based on a recording of the time of experimentation, measured to 1-minute accuracy, from switching on the power installation to the stop command. Apart from the direct running costs of the installation, which consist mostly of electricity costs, this includes all additional costs necessary to realize the experiment including but not limited to cryogenic liquids, use of all laboratory facilities and workshops, use of all electronic equipment and computer facilities and support by the local scientific, technical and administrative staff, in preparation, execution and evaluation of the experiment. The user will receive training in the operation of the installation and its security aspects.

B.1.3.7 Milestones and reviews

List and schedule of milestones					
Milestone no.	**Milestone name**	**WP no.**	**Lead beneficiary**	**Delivery date from Annex I**	***Comments***
M1.1	Kick-off meeting	1	CNRS-LNCMP	M1	
M1.2	CB meetings	1	CNRS-LNCMP	M6,M12,M18, M24,M30,M36, M42, M48	Inventory state of project, decision on organizational aspects
M2.1	Call for proposals	2	FZD	M2,M8,M14, M22,M28,M34, M40	Provision of application forms and decision on deadlines
M2.2	Announcement topical courses	2	FZD	M3,M30	Decision on financial and organisational aspects
M2.3	Announcement schools	2	FZD	M10, M24	Decision on financial and organisational aspects
M2.4	Announcement user meetings	2	FZD	M3,M15,M24, M36	Decision on financial and organisational aspects
M2.5	Sel Com meetings	2	RU	M4,M10,… M36, M42	Decision on proposal ranking
M7.2.1	Literature review heat transfer	7	RU	M6	Decision which test configurations will be most promising
M7.2.2	Improved field stabilization	7	CNRS-GHMFL	M12	Decision which improve-ments will be pursued
M7.2.3	Radial access options	7	CNRS-GHMFL	M12	Decision on geometry of radial access coils
M 8.1.1	Pilot MC exp.	8	CNRS-LNCMP	M24	Report, decision to proceed with pulsed field photo-conductivity
M 8.3.1	Pilot TPC exp.	8	CNRS-GHMFL	M24	Decision to proceed with implementation of TPC modules
M 8.4.1	Pilot imaging exp.	8	RU	M24	Decision to proceed with polarized PL and MOKE detection schemes
M 9.3	Pulsed NMR experiment	9	CNRS-LNCMP	M36	Decision to open the setup to external users
M 9.4	Advanced NMR exp.	9	CNRS	M24	User validation and feedback, choice of improvements
M 9.5	Pilot DNP exp. 20 T SC	9	RU	M36	
M 9.6	Pilot single scan exp.	9	RU	M36	

Tentative schedule of project reviews			
Review no.	**Tentative timing, i.e. after month X = end of a reporting period**	***planned venue of review***	***Comments , if any***
1	After project month: 24	**Nijmegen**	**Mid-term review**
2	After project month: 48	**Grenoble**	**Final review**

B.2 Implementation

B.2.1 Management structure and procedures

The consortium management structure has been established to ensure efficient and effective management of all the operational, technical and financial aspects of the EuroMagNET II I3. The governance structure will consist of a **coordinator** and a **coordination board**, which will be seconded by a **selection committee** and a **user committee**. The Consortium Management, the Networking Activities, the Transnational Acces and the Joint Research Activities are organised into **work packages** (WP). This structure is quite similar to that used for EuroMagNET, where it operated very smoothly and successfully. A new element, the user committee, was added to the proposed management structure of EuroMagNET II to give the high field users more influence on implementing user related aspects of the project.

The project will be coordinated by the CNRS. The **coordinator**, Dr. Geert Rikken (CNRS-LNCMP) has the necessary experience to manage this project, as he has already coordinated an FP6 design study (DeNUF) and is a member of the Coordination Board of EuroMagNET I. The CNRS is the largest European research operator, and has been responsible for the coordination of many European projects in the current and in previous framework programmes. Its administrative services will take charge of the reception of the project funds from the European Commission and of all of the bureaucratic matters related to the project. The same services will ensure that the transfer of the agreed amounts of money to each of the partners within the shortest possible time after reception from the EC.
The Coordinator will be the intermediary between the Commission and the beneficiaries of the I3. He will chair the Coordination Board, and will be assisted by a 0.5 administrative person, in addition to all the necessary personnel of the central and local administrative staff of the CNRS.

The **Coordination Board** (CB) will be composed of the large scale infrastructure directors and a user representative. The CB will be in charge of all decisions relevant to the EuroMagNET II I3 , such as, but not limited to:
· coordinating the formulation of the annual implementation plans;
· guaranteeing adequate administrative and scientific project controlling with respect to deliverables, milestones and reports;
· taking care of financial, budgetary, time planning and contract matters;
· organizing and validating the annual reports and cost statements to the Commission;
· monitoring and coordination of the flow of information within the consortium;
· decisions on dissemination and management of knowledge.
Weekly contacts will be implemented among the members of the CB by telephone, email and video-conferencing. The CB will meet at least twice a year to discuss the work package progress reports with the **Work package Leaders** (WL), to evaluate the overall progress of the EuroMagNET II I3 and to establish the implementation plan for the next 18 months.

Each work package will have a Work package Leader who will be responsible for coordinating the work plan of his/her work package and in particular for the flow of information and human resources between the participants of the work package, for monitoring progress towards milestones and deliverables and for reporting to the Coordination Board. Each work package leader will have regular contacts with all the members of his/her work package.
Each work package will have regular meetings twice a year, organized by the WL, and meetings on specific topics, that may be called by any participant of the work package when the need arises.

If necessary, the CB may appoint **External Experts** to provide top-level guidance and feed-back to the EuroMagNET II consortium on specific topics and on actions that are relevant to the needs of European high magnet field science. Each appointed expert will sign a non-disclosure agreement. Financing of these experts will be done by the beneficiary responsible for the work package the expert is needed for.

In order to represent the interests of all beneficiarys in the consortium, a **Council** representing all contractors with a voting weight according to their financial involvement in the project will be created, that meets once per year together with the user meetings. This Council will validate the operation of the consortium during the past 12 months and the program for the next 18 months. In case of disagreement between the Council and the Coordination Board, the Coordinator will decide after consultation of the Community Services.

In order to represent the interests of the high field user community, a **User Committee** (UCom) will be created, the four members of which, all external to the infrastructures, will be elected for a period of one year by the user community during the annual **User meeting.** This body will collect all suggestions, requests or criticism of the users and will transmit them to the CB. The chairman of the User Committee will be part of the Coordination Board so that the users are represented at the highest level of the consortium management and can influence the implementation of the project. During the next User meeting the UCom will report to the users and collect the feedback.

The evaluation of proposals for transnational access, secondments etc will be done by a **Selection Committee** (SelCom) twice per year. In view of the thematic diversity of high magnetic field science, this SelCom will be divided into four thematic sub-committees that will each have one representative of the large infrastructures and two external members, selected for their competence and international reputation in the relevant domain. The SelCom meetings will rotate between the different infrastructures.

The main tool that will be used to coordinate activities will be a **web site** that will be implemented and updated continuously under supervision of the Coordinator. Internal components of this web-site will be accessible only for the EuroMagNET II beneficiarys and the European Commission services, and will serve to manage the project by providing all relevant information on administrative and scientific issues. For communication outside the EuroMagNET II consortium, open web page will be used for information, posting lectures and hiring. A **flyer** describing EuroMagNET II and in particular its TNA activities will be created and will be distributed by scientists of the infrastructure at conferences. For all work packages, exchanges of personnel for extended periods are planned to improve interactions and communications.

Each work package leader will provide the Coordinator every 6 months with a **periodic activity report** containing the progress towards the planned deliverables and the work plan for the next 6 months. This report will be examined by the Coordination Board. A consolidated report on each one-year period will be set up by the work package leaders and validated by the Coordination Board before its transmission to the European Commission services. This report will include both the scientific and the administrative reports for the period concerned and the updated implementation plan for the next 18 months. The quality control of the project will be implemented by the Coordination Board. But, all collaborators in the consortium understand the importance of quality standards in the conduct of this project and are highly motivated to apply "best scientific practices" in the implementation of their work.

After negotiation with the Community Services on the funding of the EuroMagNET II I3 and before signature of the contract by the Coordinator and the EC, the contractors will sign a **Consortium Agreement**. The purpose of this Consortium Agreement is to specify the organization of the work between the contractors, to organize the management of the project, to define the rights and obligations of the contractors, including, but not limited to, their liability and indemnification, to supplement the provisions of the contract concerning access rights and to set out rights and obligations of the contractors supplementing but not conflicting with those of the contract

B.2.2 Beneficiaries

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

Beneficiary 1: CNRS
The Centre National de la Recherche Scientifique is Europe's largest basic research organization, covering all areas of scientific research. Apart from its own research laboratories, it is strongly involved in laboratories that are jointly run with other French research organizations or French universities. Two CNRS infrastructures participate in this I3 project:
- The GHMFL (Grenoble High Magnetic Field Laboratory) has 53 permanent staff members plus 11 temporary collaborators and an annual running budget of 3 M€, excluding salaries. It has a strong in-house research program in areas like high field nuclear magnetic resonance, electron paramagnetic resonance and semiconductors spectroscopy. Furthermore it has a strong magnet technology program, designing and building state-of-the-art resistive and hybrid magnets. Within this I3 project, the GHMFL will
(i) provide full transnational access and support to its installation (WP 3). Whereas under FP6 this access was very successfully executed in a RITA program, it will now be fully integrated into the EuroMagNET II TNA activities to further increase its efficiency and impact.
(ii) will coordinate the joint research activity on magnet technology and operation (WP 7), based on its extensive and long standing experience in this domain.
(iii) will fully participate in all the JRAs (WP 7- 9) to further expand and improve ongoing activities in these domains.
The senior staff members of the GHMFL involved in the execution of this project are:
Dr. J.L. Tholence, director, expert on magnetism and superconductivity (WP1, leader WP3)
Dr. M. Potemski, expert on semiconductor magneto-spectroscopy (WP2,WP3,WP8)
Dr. D. Maude, expert on magneto-transport and semiconductor (WP3, WP8)
Dr. C. Berthier, expert on superconductivity and high field NMR (WP3, WP9)
Dr. M. Horvatic, expert on high field NMR (WP3, WP9)
Dr. S. Krämer, expert for high resolution NMR, field stability and homogeneity (WP3, WP7, WP9)
Dr; I. Sheikin, expert on magneto-transport and correlated electron systems (WP3)
Dr. A. L. Barra, expert on high field electron spin resonance (WP3)
Prof. dr. J.C.Portal, expert in semiconductors, mesophysics (WP3)
Dr. A.de Muer, expert in magnetism and transport (WP3)
Dr. F. Debray, expert on coil design and hydraulics (WP7)
Dr. P.Petmezakis, expert in command and stability of the power supply (WP7)
Dr. W.Joss, expert in magnets technology (leader WP7)

- The LNCMP (Laboratoire National des Champs Magnétiques Pulsés) is a joint laboratory between the CNRS and two Toulouse universities. It has researchers and technicians and receives funding from all three organizations. Currently, the LNCMP has 37 permanent and 13 non-permanent staff members and an annual budget of 1 M€, excluding salaries. The LNCMP is running a strong in-house research program on high T_c superconductors, quantum magnetism and single nano-object transport. In the area of magnet technology, the LNCMP has a large activity in advanced conductor materials. Within this I3 project, the LNCMP will
(i) coordinate the EuroMagNET II consortium (WP1). Under FP6, it has already successfully coordinated the DeNUF design study on pulsed field technology uniting all European large pulsed field facilities.

(ii) provide full transnational access and support to its installation (WP 4). Under FP6 this access was very succesfully provided in the I3 EuroMagNET. It will now be fully integrated into the EuroMagNET II TNA activities to further increase its efficiency and impact.
(iii) will fully participate in all JRAs (WP7-WP9) to further expand and improve ongoing activities in these domains.
The senior staff members of the LNCMP involved in the execution of this project are:
Dr. G. Rikken, director, expert in magneto-optics (coordinator, leader WP1, WP4)
Dr. O. Portugall, expert on spectroscopy in pulsed fields and single turn coils (WP1, leader WP4)
Dr. H. Rakoto, in charge of user activities, expert in magnetization measurements (WP4)
Dr. P. Frings, in charge of the generator and pulsed field coil design and construction (WP7)
Dr. F. Lecouturier, in charge of high field materials research (WP2, WP7)
Dr. C. Proust, expert on high Tc superconductors (WP2, WP4)
Prof. dr. B. Raquet, expert on nano-object transport measurements (WP4, WP8)

Radboud University Nijmegen

Beneficiary 2: RU
Two laboratories of the Radboud University Nijmegen (RU) participate in this project; the High Magnetic Field Laboratory (RU-HFML) and the solid state NMR laboratory (RU-NMR). They are both part of the Institute for Molecules and Materials (IMM). The Radboud University is a private, not-for profit organization with significant government funding.
HFML is financed by running grants of the Radboud University and the foundation Fundamenteel Onderzoek der Materie (FOM), and through project funding and the Access to Large Installations programme of the European Union. It has 13 permanent staff members (scientists, technicians and a secretary) and 9 graduate students and post-docs, and the annual budget is 1.4 M€ excluding salaries and overhead. Being part of the renowned research institute IMM assures a lively academic environment which provides top class expertise in the fields of (solid state) NMR, spectroscopy, supramolecular chemistry and nanoprobing. HFML has its own research program on fundamental properties of top-down (mainly semiconductor based) and bottom up (based on supramolecular chemistry) nanostructures with emphasis on electron correlation effects and self organisation. It has recently received investment grants for a 45 T hybrid magnet and a dedicated FIR FEL. Within this I3 project, the RU will
(i) provide full transnational access and support to its HFML installation (WP 5). Under FP6, this access was very succesfully provided in the I3 EuroMagNET. It will now be fully integrated into the EuroMagNET II TNA activities to further increase its efficiency and impact.
(ii) will coordinate the joint research activity Nano measurements and local spectroscopy (WP 8), based on its extensive experience in this domain.
(iii) will fully participate in the all JRAs (WP 7-9) to further expand and improve ongoing activities.

The senior staff members of the RU-HFML involved in the execution of this project are:
Prof. Dr. J.C. Maan director (WP1, leader WP5, WP8)
Dr. P.C.M. Christianen, expert on high field optics and spectroscopy (WP2, WP5, leader WP8)
Dr. H. Engelkamp, expert on FIR magneto-spectroscopy (WP5)
Dr. J.A.A.J. Perenboom, facility manager (WP2, WP5)
Dr. S. Wiegers, expert on coil design (WP7)
Dr. U. Zeitler, expert on transport and magnetization experiments on semiconductors (WP5,WP8)

The solid-state **NMR** group at the RU has a long-standing international reputation in the advancement of new methodologies in NMR aimed at materials research involving quadrupolar nuclei. Recently the group has pioneered various options for NMR sensitivity enhancement, including the implementation of microcoil technology in solid-state NMR. The group has a unique NMR infrastructure comprising 5 state-of-the-art spectrometers and probes. In EuroMagNET I the group coordinated the development of special methods for NMR in resistive magnets, including

multidimensional high resolution NMR, versatile low temperature NMR and a first exploratory investigation of pulsed magnetic field NMR.
The senior staff members of the RU-NMR involved in the execution of this project are:
Prof. dr. A. Kentgens, expert on high field NMR (WP9)
Dr. A. Brinkman, expert on high field NMR (WP9)
Dr. J. van Bentum, expert on high field NMR and ESR (WP9)

Forschungszentrum Dresden Rossendorf

Beneficiary 3: FZD

The Forschungszentrum Dresden-Rossendorf (FZD) is a multi-disciplinary research centre with over 600 employees, legally a private, but public-body and non-profit research organization and funded by the Free State of Saxony and the Federal Government of Germany. It has a total annual budget of around 60 M€. The institute directors are also full professors at the Technical University of Dresden. The FZD institute Hochfeld-Magnetlabor Dresden (HLD) has about 13 permanent staff members plus 14 collaborators on temporary contracts. Their research is focused on the electronic properties of solids in high magnetic fields, investigated with a host of different techniques and on the optical and THz spectroscopy of semiconductors, including the development of novel THz sources and detectors. Within this I3 project, the FZD will
(i) provide full transnational access and support to its recently completed HLD pulsed field installation (WP 6) which is currently the only one worldwide that can be operated in combination with a FEL. HLD started given access to its installation in 2007, within the context of EuroMagNET but without the corresponding funding.
(ii) will coordinate the Networking activity (WP 2).
(iii) will fully participate in all the JRAs (WP7-9) to further expand and improve ongoing activities.
The senior staff members of the FZD involved in the execution of this project are:
Prof. Dr. Jochen Wosnitza: director of the HLD, expert on high-magnetic field research on correlated electron materials (WP1, leader WP2, leader WP6)
Dr. Thomas Herrmannsdörfer: expert on low-temperature physics and NMR (WP6, WP9)
Prof. Dr. Manfred. Helm, expert on THz magneto-spectroscopy (WP8)
Dr. Sergey Zvyagin: expert on ESR of correlated electron systems (WP6)
Dr. Sergey Zherlitsyn: expert on coil design, and ultrasound measurements of solids (WP6, WP7)
Dr. Yurii Skourskii: expert in pulsed field electrical transport and magnetization experiments (WP7)
Dr. Harald Schneider: expert on semiconductors, THz detectors and spectroscopy (WP6, WP8)
Dr. Stephan Winnerl: expert on THz physics and technology (WP6, WP8)

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Beneficiary 4: ULEI

Already in 1951, Nuclear Magnetic Resonance (NMR) was observed for the first time in Germany in Leipzig. Magnetic Resonance prospered not only in physics and after the unification, major investments made Leipzig the leading site in Germany for Magnetic Resonance research with the focus on physics applications. A large number of superconducting magnets, from 17.6 Tesla down to 2.3 Tesla, and other resources are available through Leipzig's Center of Magnetic Resonance.
In 2006 J. Haase took on the chair for experimental solid-state physics in Leipzig with the focus on the application of Magnetic Resonance for the investigation of correlated electronic matter, but also for the study of other modern materials. As the Director of Leipzig's Center of Magnetic Resonance,

J. Haase is also engaged in broader applications and he leads a special teaching effort in Magnetic Resonance that supplies physics and surrounding institutes with students. The group is aided by two full-time staff engineers and 1.5 technical staff. Currently, one additional postdoctoral researcher is employed who works on high-temperature superconductors. While working at the IFW-Dresden, J. Haase lead the worldwide first successful effort in carrying NMR into pulsed high field magnets (60 Tesla, and 2.4 GHz) by showing that it is possible to do single-shot NMR in such magnets and by devising methods that deal with short-comings when using such systems. With the move to Leipzig, after the new group has established we seek to further advance the new methods for the investigation of high-field physics in collaboration with the pulsed high field laboratories in Dresden and Toulouse.
With the development of Magnetic Resonance in the pulsed fields will be involved:
Prof. dr. J. Haase (group leader, pioneer in NMR in pulsed magnetic fields) (WP9)
Prof. dr. A. Pöppl (specialist in pulsed electron paramagnetic resonance) (WP9)
PD dr. M. Bertmer (specialist in NMR in chemistry) (WP9)

UNIVERSITY OF OXFORD

Beneficiary 5: UOX-DK

The Department of Physics, Oxford University is one of the largest in the UK and has been awarded the highest rating of 5* in all Research Assessment exercises. The condensed matter sub-department, headed by R. Nicholas has an active programme of research into a variety of nanostructures, quantum information processing, bio-nanotechnology and correlated electron systems, which are studied using infrared to UV spectroscopy, fast pulse optics and terahertz spectroscopy, high pressures, magnetisation studies, force microscopy as well as both steady and pulsed magnetic fields. The department has a long history in magnetic field research and is a partner in the EuroMagNET project (FP6 RII3-CT-2004-50623), and the DeNUF design study project (FP6 Design Study 011760)
The senior staff member of the UOX-DK involved in the execution of this project is:
Prof. R. Nicholas, expert in semiconductor magneto-transport and magneto-spectroscopy (WP2, WP8)

Beneficiary 6 TUT

The solid state NMR group at the Tallinn University of Technology (formerly at NICPB) has been a leading developer of mechanical reorientation based resolution enhancement techniques. Barriers of 15, 25 and 50 kHz rotation were first broken by this group. The most recent technique of speed switching at 1 MHz/s rate opens truly uncharted territory in NMR. In addition to first MAS,nutation and satellite transition spectra, members of the group invented the double rotation (DOR) approach for high resolution of quadrupolar nuclei. The demonstration of homonuclear high resolution 2D correlation spectroscopy of quadrupolar nuclei shows the potential of the method for materials studies.
The senior staff member of the TUT involved in the execution of this project is:
Dr. A. Samoson, expert in NMR methodology (WP9).

Beneficiary 7 WI

Magnetic resonance at Weizmann Institute originates with S. Meiboom, who shortly after the Institute's creation and under guidance of F. Bloch built one of the first NMR instruments outside the US. Following Meiboom's seminal discovery of NMR's phase sensitive character, the Weizmann impact in the fields of NMR and MRI has continued unabated. Prof. Frydman is the latest among a long string of Faculty that since 1950 have joined the Institute's NMR activities; research in the Frydman lab centers on developing new methods in NMR and MRI, and on applying them to chemical, biochemical, biological and materials investigations. This work is carried out on five instruments with solution, solids, hyperpolarizing and imaging capabilities at the group's exclusive disposition operating at 3.35, 4.7, 7, 11.7 and 14.1 T. Shared Institute-wide NMR facilities at the Weizmann are also used, including 4.7 and 9.4 T animal imaging scanners, 11.7 and 18.8 T cryoprobe-equipped biomolecular spectrometers, and a research-dedicated 3T whole-body MRI.

An important spectroscopic development pioneered and exploited by the Frydman group during the last years concerns the acquisition of multidimensional NMR, MRS and MRI data within a single scan. This "ultrafast" acquisition scheme differs radically from hitherto available protocols, which required independent time variables for encoding the spin behavior along each individual spectral axes. By departing from this way of acquiring the NMR data new types of applications become possible, including the acquisition of high-resolution 1D and 2D NMR spectra on inhomogeneous or unstable fields. This latter development forms an integral part of the WP9 package in this project

The senior staff member of the WI involved in the execution of this project is:
Prof. dr. L. Frydman, expert in the development of ultrafast multidimensional MR (WP9).

B.2.3 Consortium as a whole

B.2.3.1 Completeness

The four high field infrastructures that participate in this project constitute the totality of Europe's large high field infrastructures. Between them, they can provide access and support for almost all versions of high field magnets, from dedicated superconducting magnets (e.g. for NMR and EPR), general purpose resistive magnets (up to 34 T, GHMFL and HFML), non-destructive pulsed magnets (up to 78 T, HLD and LNCMP) up to 300 T destructive single turn coils (LNMCP). They posses sophisticated scientific equipment around the magnets, which is very often developed in-house, as commercial equipment is rarely adapted to the stringent constraints of high field experiments. These two factors together guarantee that the consortium can offer state-of-the-art access and support to all qualified high field users, as confirmed by the past access record of the participating infrastructures; 900 access projects executed during the last five years, with on average one publication per project. The instrumentation development track-record of the infrastructures, coupled to the specific expertise of the other groups participating in the JRAs, guarantees that the instrumentation developments, proposed in the three JRAs of this project, will be successfully implemented, to the benefit of all users. The JRA topics have been selected after consultation of the user community, at the EuroMagNET and the GHMFL-RITA user meetings and represent the developments that are judged most wanted by this community.

B.2.3.2 Complementarities

Not only does the consortium cover all principal aspects of top level high magnetic field science, it does so in an efficient and complementary manner. The four infrastructures are geographically well spread across Europe. Although in principle travelling is not a problem for guest researchers, the vicinity of a facility does play a role in the research choices of nearby research groups. Therefore it is expected that the geographical spread will help to attract a wider user community. There is a large community of users working in solid state physics (low dimensional systems, nanoscience, correlated electron systems, etc), which profit from all four high field infrastructures. In addition to this common user community, the four infrastructures have quite different thematic specializations with the corresponding user groups. Of the two static field infrastructures, the HFML concentrates more on topics related to molecular and self assembled systems, whereas the GHMFL is more focussed on correlated electronic systems like heavy fermions and quantum magnetism. They have different approaches to coil technology, with each different specific advantages and disadvantages. Of the two pulsed field infrastructures, the HLD infrastructure will fully exploit its worldwide unique coupling to the ELBE FEL to do advanced terahertz spectroscopy on semiconductors. The LNCMP, the other pulsed field infrastructure, will build on its very long experience in very sensitive low noise transport and UV-VIS spectroscopy experiments, like on single nano-objects and high T_c superconductors.

B.2.3.3 Subcontract

Participant 3 FZD has planed a provisional budget of 6.300.00 Euros on the way to provide Certificates on Financial Statements by an external accredited company.

B.2.4 Resources to be committed

B.2.4.1 Mobilization of resources

The four infrastructures in the consortium each have as principal missions to do in-house research, magnet technology and instrumentation development and external user access and support. The totality of their financial and human resources is dedicated to these purposes, which are in essence also the aims of EuroMagNET II

In order to fulfil the specific objectives of the EuroMagNETII I3, and in addition to the listed staff members and the demanded EC contribution, the following WP specific resources will be mobilized.

· WP 1: Requested EC contribution: 400 k€

Principal cost is personnel. In addition to those financed from the EC contribution, financial and personnel administrations of each contractor will assist in preparing the annual reports. Computer service groups will assist in installation and operation of the EuroMagNETII website (CNRS) and of databases (FZD). The consortium will be supported in all EC related issues of the work packages by local staff responsible for EC contracts.

· WP 2: Requested EC contribution: 900 k€

Principal costs are those of the schools, topical courses and thematic networks and the personnel that will be hired to accompany theses activities. In addition to those funded by the EC contribution, financial, administrative and public relations personnel of partner 3 (FZD) will assist the WP leader in the networking activities, such as announcements of schools, workshops and meetings as well as dissemination of results and outreach activities.Additional personnel of the partners of the Thematic Network task leaders (CNRS, RU, UOX-DK) will support these leaders in organisational aspects of the Thematic Network workshops.

· WP 3-6: Total requested EC contribution 4,2 M€

Major cost items are electrical power (DC installations), coil construction and maintenance, and cryogenic liquids. The infrastructures offer access under this project at a price below the real cost. Furthermore, past experience has shown that the infrastructures provide much more access units to TNA eligible user groups than foreseen in the contract (sometimes up to a factor of two more). This policy is financed from their own resources because it is judged to be beneficial to the development of European high magnetic field science. Furthermore, the infrastructures continuously make investments in their installation and the scientific instrumentation around it, funded from their own resources, which will be of benefit to all users.

· WP 7-9: There where necessary and possible, available specific equipment, technical staff and magnet infrastructure not foreseen in the original proposal will be provided in order to realize the aims of the Joint Research Activities. In particular:

WP 7: Requested EC contribution: 800 k€.

Major costs are personnel. The balance between contributions of experienced staff member and the requested temporary human resources varies considerably in WP 7 per Task. 70 % of the estimated human effort will be provided by personnel of the infrastructures for Task 7.1, and 60 % for Task 7.2. In Task 7.3 the requested temporary personnel will perform 60% of the work. The permanent staff will mostly be engineering and technical staff.

WP8: Requested EC contribution: 600 k€

Major costs are personnel. The EC contribution will cover the man months of the temporary staff (168, 79%). All other resources are provided by the participating facilities and user groups. These resources include material and workshop costs to built the prototype equipment, the use of advanced electrical, optical (lasers, spectrometers, detectors, etc), cryogenic and nano-positioning equipment and magnets, and the man months of the permanent technical and scientific staff involved (44, 21%).

WP9: Requested EC contribution: 600 k€

Major cost item is personnel. The GHMFL activity is based on and embedded in the already operating NMR user facility at GHMFL. The RU activity is based on the successful activities of the

NMR group. The HLD and LNCMP activities will expand on the pioneering work at ULEI. Assembly of NMR probes and other hardware will be performed by the mechanical and electronics departments of the participants. To a large extent the existing NMR equipment, like spectrometers and diagnostic hardware of the different participants in this WP will be used.

The balance between contributions of experienced staff members and the requested temporary human resources will ensure that the full potential of the contractors will be used in an effective and coherent way and that the temporary staff will be correctly accompanied and supported.

The total financial plan is based on experiences of the partners with many national and EC related activities. All of them were or are in charge in projects that demanded financial estimations based on the same financial criteria as apply to the current project. These estimations are therefore realistic and reliable and a successful execution of the project based on them is therefore likely.
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Table B.2.3 Other major cost for the implementation of the project

WP	Description	Cost estimate
3	Investments infrastructure GHMFL	7 000 000
4	Investments infrastructure LNCMP	500 000
5	Investments infrastructure HFML	10 000 000
6	Investments infrastructure HLD	1 000 000
9	Electronics for pulsed field spectrometers LNCMP & HLD	220 000

B.2.4.2 Access costs:

The unit fee cost to the high magnetic field infrastructures are determined by several factors:
The high field magnets in use at the infrastructures are all custom designed, built and maintained by in-house engineers and technicians. As these coils are strained up to the thermal and mechanical limits, their lifetime is rather limited. This is particularly true for pulsed coils, which should be considered as consumables. For the DC infrastructures, the high electricity consumption, up to 24 MW, is also an important cost factor. For the pulsed field infrastructures, the liquid nitrogen needed to cool the magnets between shots is an important cost factor.
Apart from the magnetic field itself, the infrastructures provide all the necessary state-of-the-art scientific auxiliaries and instrumentation, necessary to perform experiments in high fields. This ranges from cryogenic sample environments to advanced spectroscopy systems. The severe temporal and spatial constraints imposed by high field magnets makes that the instrumentation around the magnets is also custom designed and built in-house, or at least that major modifications have to be made to commercial equipment. This also requires a large number of different technical specialists. Therefore a large in-house technical staff is necessary to offer complete access to experiments in high magnetic fields.

The real costs for a magnet hour are currently around 1200 €. For strategic reasons, the GHMFL and the HFML have decided to charge the same and significantly reduced **magnet hour cost** of **900 €**. For similar reasons, the LNCMP and the HLD have decided to charge the same **magnet shot cost** of **400 €** whereas the real costs per shot are around 650 €.

It should be noted that all the infrastructures have in the past supplied much more access to TNA eligible users than charged to the EC contracts, sometimes up to a factor of two more.

The access costs of the TNA program of EuroMagNET II comprise **travel and subsistence support** to qualified TNA users, the cost of which on average amounts to roughly 10 % of the unit fee costs. The T&S support will basically cover travel to and from the infrastructure, accommodation and living allowances, for one external user per qualified proposal, or two users if the complexity of the experiment warrants it, subject to approval by the infrastructure.
The infrastructure will reimburse the **travel costs** on the basis of second-class rail fare. The infrastructure may authorize air travel, if this means of transport is the most economic, or if the visitor has to travel over more than 1000 km or has to cross water and surface transport would be too demanding. The air fare will be paid if authorization has been requested and obtained beforehand and the relevant ticket is attached to the claim form.
The standard daily **subsistence** rate is 30 €. Provision of accommodations, in guest-rooms or hotels, will be at the discretion of the infrastructure, and the costs will be covered directly by the infrastructure. If no accommodation is provided by the infrastructure, an additional daily allowance of up to 45 € is granted. The number of complete daily subsistence payments made to the user is determined by the number of nights, subject to approval by the infrastructure.

TABLE B.2.4.a

Calculation of the Unit Cost for Transational Access

Participant number	**1**	**Organisation short name**		**CNRS**	
Short name of Infrastructure	**GHMFL**	**Installation number**		**Short name of Installation**	
Name of Installation	**static field installation**			**Unit of access**	**Magnet hour**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Experiences			980 000
	Power installation maintenance			1 400 000
	Magnet construction and maintenance			1 800 000
	Electrical power and energy			3 600 000
	Cryogenic liquids			480 000
	Materials, services, consumables			810 000
	Services (housing, heat, electricity, cleaning, telephone)			P/M
	Travel and subsistence 250 TNA users			200 000
	Total A			**9 270 000**
	of which subcontracting (A')			
B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	Staff scientists 4 fte	25 040	58	1 452 320
	Staff teaching scientists 0,7 fte	3130	63,5	198755
	Engineers 5 fte	31300	43,7	1367810
	Assistent engineers 15 fte	93900	33,2	3117480
	Technicians 11 fte	68860	29,4	2024484
	Temporary staff 6 fte	37560	25	939000
	Research and teaching (4,4 fte)			0
	Other staff (7 fte)			0
				0
	Total B			**9 099 849**
C. Indirect eligible costs = 7% x ([A-A']+B)				1 285 889
D. Total estimated access eligible costs = A+B+C				19 655 738
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time				15 200
F. Fraction of the Unit cost to be charged to the proposal [1]				70%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)				**900**
H. Quantity of access offered under the proposal (over the whole duration of the project)				2 400
I. Access Cost [2] = G x H				**2 160 000**

TABLE B.2.4. b

Calculation of the Unit Cost for Transational Access

Participant number	**1**	**Organisation short name**		**CNRS**	
Short name of Infrastructure	**LNCMP**	**Installation number**		**Short name of Installation**	
Name of Installation	**pulsed field installation**			**Unit of access**	**Magnet shot**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs

Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .	**Eligible Costs (€)**
Buidling maintenance, Utilities, Services	250 000
Magnet materials	100 000
Cryogenic liquids (helium, nitrogen)	240 000
Electronic & optical equipment	180 000
Informatics	120000
Maintenance generator	80000
Travel and subsistence 150 TNA users	75 000
Other materials, services and consumables	200000
Total A	**1 245 000**
of which subcontracting (A')	

B. Estimated personnel direct eligible costs needed to provide access within the project life-time

Category of staff (scientific and technical only)	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
Staff scientist 7,55 fte	47 263	41	1 937 783
Engineers 8 fte	31300	39	1220700
Technicians 12 fte	75120	21	1577520
Temporary scientists 5,1 fte	31926	21	670446
Temporary engineers 5 fte	31300	24	751200
			0
			0
			0
			0
Total B			**6 157 649**

C. Indirect eligible costs = 7% x ([A-A']+B)	518 185
D. Total estimated access eligible costs = A+B+C	7 920 834
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time	12 500
F. Fraction of the Unit cost to be charged to the proposal [1]	63%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)	**400**
H. Quantity of access offered under the proposal (over the whole duration of the project)	1 600
I. **Access Cost [2] = G x H**	**640 000**

TABLE B.2.4.c

Calculation of the Unit Cost for Transational Access

Participant number	**2**	**Organisation short name**		**RU**	
Short name of Infrastructure	**RU-HFML**	**Installation number**	**1**	**Short name of Installation**	**20MW resistive/hybrid magnet**
Name of Installation	**High Field Magnet Laboratory**			**Unit of access**	**Magnet hour**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs

Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .	**Eligible Costs (€)**
Electrical power and energy	2 260 000
Maintenance costs of installations	320 000
Replacement costs of magnet coils	120 000
Cryogenic liquids (nitrogen and helium)	144 000
Materials, services and consumables (internal)	100 000
Materials, services and consumables (external orders)	200 000
Services (housing, heat, electricity, safety, cleaning, telephone)	P/M
Travel and subsistence 90 TNA users	90 000
Total A	**3 234 000**
of which subcontracting (A')	

B. Estimated personnel direct eligible costs needed to provide access within the project life-time

Category of staff (scientific and technical only)	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
Senior scientists (installation and program, 3.1 fte)	17 384	73,3646224	1 275 371
Junior scientists (user support, 1,5 fte, 20%)	8412	29,881658	251364,5071
Technicians (6.0 fte)	33648	42,8647232	1442312,206
Secretariat (0.7 fte)			0
(direct costs, 1402 productive hours per year, 2% infl)			0
Research and teaching (10.5 fte)			0
Central services			0
			0
			0
Total B			**2 969 047**

C. Indirect eligible costs = 7% x ([A-A']+B)	434 213
D. Total estimated access eligible costs = A+B+C	6 637 261
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time	4 800
F. Fraction of the Unit cost to be charged to the proposal [1]	65%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)	**900**
H. Quantity of access offered under the proposal (over the whole duration of the project)	1 200
I. Access Cost [2] = G x H	**1 080 000**

Table B.2.4d

Calculation of the Unit Cost for Transational Access

Participant number	**3**	**Organisation short name**		**FZD**	
Short name of Infrastructure	**HLD**	**Installation number**		**Short name of Installation**	
Name of Installation	**Dresden High Magnetic Field Laboratory**			**Unit of access**	**Magnet pulses**

A. Estimated direct eligible costs of providing access within the project life-time excluding personnel costs	Describe the direct eligible costs for providing access to the installation over the project life-time (e.g. maintenance, utilities, consumable costs). All contributions to capital investments of the infrastructure are not eligible .			**Eligible Costs (€)**
	Maintainance costs of installations			2 000 000
	Materials, consumables, services			1 000 000
	Cryogenic liquids			200 000
	Travel and subsistence 70 TNA users			40 000
	Total A			**3 240 000**
	of which subcontracting (A')			
B. Estimated personnel direct eligible costs needed to provide access within the project life-time	**Category of staff (scientific and technical only)**	**Nr. of hours (1)**	**Hourly rate (2)**	**(3) = (1) x (2)**
	2,5 Scientists	16 800	30	504 000
	1 Engineer	6 720	25	168000
	2,5 Technicans	16800	20	336000
				0
				0
				0
				0
				0
				0
	Total B			**1 008 000**
C. Indirect eligible costs = 7% x ([A-A']+B)				297 360
D. Total estimated access eligible costs = A+B+C				4 545 360
E. Total estimated quantity of access provided to all normal users of the infrastructure (i.e. both internal and external) within the project life-time				6 400
F. Fraction of the Unit cost to be charged to the proposal [1]				56%
G. **Estimated Unit cost charged to the proposal** = F x (D/E)				**400**
H. Quantity of access offered under the proposal (over the whole duration of the project)				750
I. **Access Cost [2] = G x H**				**300 000**

B.3 Impact

B.3.1 Strategic impact

EuroMagNET II is aimed at further improving high magnetic field science in Europe by developing better instrumentation and magnets, by widely distributing the available knowledge and expertise within the European high field community and by offering the best possible access and support to the best European high field access requests. The EuroMagNET II consortium will posses record pulsed and DC magnetic fields combined with a very broad range of top-level additional experimental instrumentation . By the European approach proposed here with EuroMagNET II, the entire European scientific community can benefit from the existence of the participating infrastructures, which are essentially created and funded as national facilities. Without EuroMagNET II, only French, Dutch and German scientists will have guaranteed access to high magnetic fields.
On the scientific level the main impact will be the improvement of the performance of the European high magnetic field user community. For them the combined and reinforced expertise (both in magnet technology and in measurements techniques) of the four infrastructures will become accessible and can be used for scientific progress. Not only will this improve the quality and quantity of the output, but it may also open new domains in high field research.
On a strategic level, the creation of the EuroMagNET II consortium, uniting all European high field infrastructures, paves the way for the creation of a distributed European Magnetic Field Laboratory. Such an organisation appears to be the only possibility to bring European high magnetic field science to the level of that in the USA, where the NHMFL receives massive and coordinated funding from federal and state governments. Realization of such an infrastructure would again be to the benefit of the European high magnetic field community, which would then finally benefit from a support, similar to that available to the US high magnetic field community.
The impacts of the individual work packages can be summarized as follows:

WP1 Management
The Management WP will concern itself mainly with the administrative and financial aspects of the I3, with the representation of EuroMagNET II toward industry, the scientific community and the general public, and with the dissemination of the scientific and technical results of the project. The first task should lead to a smooth and successful implementation of the I3 which will certainly help to reinforce the European high field community. The representation and dissemination tasks will help to increase the awareness of the high field activities in Europe and will attract new users to the infrastructures.

WP2 Networking
The coordinated network activities will further unite and strengthen the European high field user community. Only by the planned concerted actions between the users and all the large European infrastructures the exchange of information and knowledge will be streamlined, the coherence in this community will increase and the promotion of high field science and technology will be largely stimulated. By organising workshops, schools, exchange programs and last but not least by awarding a EuroMagNET prize, the importance of high field science will be clearly highlighted and the visibility of this significant European research area will be strongly enhanced. Continuous outreach activities such as the planned schools, open for all interested students, public talks and the dissemination of important results by press releases and on the relevant web pages will attract young researchers to the field and new users to the facilities. These activities will be accompanied by the involvement of consortium members in organizing international conferences and symposia.

WP3-6 TNA

The TNA work packages offer European scientists access to world class infrastructures, thereby strengthening European collaborations and providing incentives for young scientists for a scientific career in Europe rather than in the USA. They strengthen magnetic field related research in Europe by building a strong user community of the major European centres for high magnetic field research. Quite another focus is the fact that the large magnetic field installations may stimulate the younger generation to choose a career in science, through their exposure to exciting and internationally oriented research work during site visits and demonstrations specifically targeted at secondary schools.

WP7 High Field User Magnet Technology

This WP will lead to an improvement of the technical performance of the four major European high field infrastructures, which be of direct benefit to the entire European high field user community. In addition, some of the activities in this WP serve directly for the two other JRAs described below (low noise operation for WP8, high homogeneity pulsed coils for WP9), which again have their own impacts.

WP8 Nano-object measurements

The combination of high magnetic fields and nano-probe techniques is worldwide virtually unexplored, yet scientifically very promising, because in this regime the electronic cyclotron orbit becomes comparable to the typical dimensions of nano-objects. The implementation of advanced nano-object instrumentation in high magnetic fields will therefore position the European high field community at the forefront of a new area of nanoscience. On one hand this development is to a great extent demanded by the existing user groups of the high field installations to enlarge and improve their experimental possibilities. On the other hand, it is anticipated that the new scientific apparatus will attract many new users from other research areas. Finally, joining the expertise of the researchers at the high field installations and the knowledge within external user groups to develop a complementary package of novel scientific equipment, will further strengthen the consistency of the European research infrastructure and will promote the initiation of new collaborations.

WP9 ES^3-NMR

The main goal for the WP9 JRA on enhanced sensitivity and single scan NMR is to create new user opportunities for NMR spectroscopy in fields beyond the commercially available range. We expect that this will have a clear impact on the research in materials science and in solid state chemistry where a new class of problems can be studied for the first time with NMR. A major impact is that these efforts will improve the accessibility of the European high field facilities for the chemical oriented research community. For the high field user facilities we expect that the developments in WP9 may lead to a more cost effective use. We expect that the sensitivity enhancement allows that more experiments can be done within the budgetary and operational limitations and thus a larger user community can be served. A major impact of WP9 is also that for the first time users gain access to ultra high pulsed magnetic fields for NMR studies of structural phase transitions in superconductors and magnetic materials and thus contribute to the understanding of fundamental problems in basic and applied materials research.

B.3.2 Plan for the use and dissemination of foreground

The scientific and technological results obtained within EuroMagNET II will be published in the appropriate open international literature, acknowledging the EC FP7 support. Intellectual property rights, where applicable, will be shared in a fair and reasonable fashion between the contractors of the work package generating these rights. The conditions will be fixed in a consortium agreement at the beginning of the project. In addition, the scientific and technical results of EuroMagNET II will be brought under the attention of a wide audience, through the EuroMagNET II web site, with links at the web sites of all beneficiaries, through a quarterly EuroMagNews bulletin, distributed amongst the scientific community, through press releases to the popular press etc. Where deemed of particularly high impact, participation in prestigious international conferences will be financed to promote recent results obtained within the EuroMagNET II framework.

B.5 Consideration of gender aspects

In the areas of mechanical and electrical engineering and the physical sciences, there is on average a large preponderance of male personnel. The research and engineering staff of the beneficiaries in this project also reflects this state of affairs. In order to try and balance this situation, in the hiring of non-permanent staff for the different tasks of EuroMagNET II, the beneficiaries will give preference to female applicants, in the case of equally qualified candidates.

In the presentation of the EuroMagNET II activities at secondary schools, particular emphasis will be put on trying to interest female students for these activities, as women are strongly underrepresented in the high field user community and the staff of the high field infrastructures, and represent therefore an important growth potential.