SIXTH FRAMEWORK PROGRAMME

Structuring the European Research Area Specific Programme

RESEARCH INFRASTRUCTURES ACTION

Contract for a:

DESIGN STUDY

implemented as

SPECIFIC SUPPORT ACTION

Annex I - "Description of Work"

Project acronym: DeNUF

Project full title: "Design study for next generation pulsed magnet user facilities"

Coordinator: G. Rikken LNCMP-CNRS

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1 Project summary

The DeNUF Design Study will develop and validate new technologies for innovative pulsed user magnet systems that will be substantially improved beyond the present state-of-the-art in terms of field strength, lifetime, cool-down time and reliability. These technologies will be used to design and operate the next generation of pulsed high field magnets at the existing user infrastructures of the participants. This joint Design Study will lead to a distributed European pulsed high magnetic field infrastructure, capable of competing with the pulsed magnetic field activities in the USA. Implementation of its results will provide the European researchers access to the highest magnetic fields under optimal conditions. It will allow to recover the European leadership in the area of high magnetic field technology and will pave the way into new areas of research in physics and chemistry in high magnetic fields.

2 Project objectives

The DeNUF Design Study will develop and validate new technologies for pulsed magnetic fields. It will provide knowledge and tools to design and operate pulsed user magnets with much higher field strengths, longer lifetimes, faster cool-down and higher reliability than currently available, by structuring and coordinating the technology research at the major European pulsed field laboratories. High reliability and long lifetime imply automatically also improved security and efficiency for the external users of such magnets.

This Design Study will lead to the construction of the next generation of pulsed magnets that will be installed and made available to the European pulsed field user community at the existing infrastructures. In contrast to pulsed magnets currently operational, which are mostly monolithic, the proposed magnets will be multi-coil in order to optimise the distribution of current density and thereby mechanical and thermal loading, resulting in higher fields, more rapid cool-down and increased lifetime and reliability. These advantages can only be obtained at the expense of elaborate modelling, improved understanding of materials, advanced fabrication technology and real-time, in-situ monitoring that will all be developped by the partners in this Design Study. The design and test of these new magnet systems will benefit from the previous investment in a 14 MJ capacitor bank (LNCMP), a 20 MW power converter with additional 2 MJ capacitor bank (HFML) and the ongoing construction of a 50 MJ capacitor bank (HLD), each an investment well above the 25 M€ level.

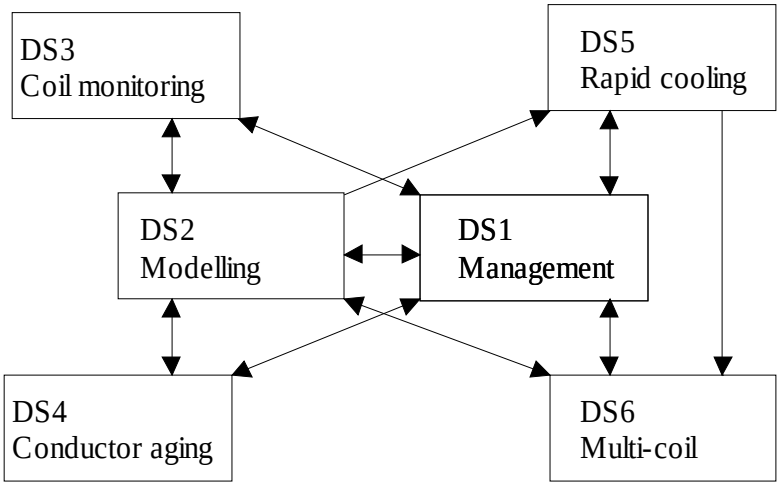
The DeNUF Design Study will provide important innovations in magnet design and operation. By structuring and coordinating European technology development in this field, it will allow the participants to achieve together the critical size needed to master all aspects of coil design and operation at the highest level world-wide. It will allow them to go beyond the targets of the German funded project at the HLD in Dresden and of the NSF funded project at the NHMFL in the USA. The results of the DeNUF Design Study will provide leadership to European high field infrastructures and consequently to the European users of pulsed field facilities. It will generate the technology to construct 80 T user coils, making at least 50 shots at full field, a performance that has not yet been obtained anywhere else. In doing so, it will open the road to coils beyond the 100 T limit, the target that has been identified by the ESF as essential to European science.

3 List of participants

Part.	Organisation	Short name	Short Description and specific roles in the consortium
1	Centre National de la Recherche Scientifique, Laboratoire National des Champs Magnétiques Pulsés, UMR CNRS-INSA-UPS, Toulouse, France	CNRS/ LNCMP	Large user facility for pulsed magnetic fields, with much experience in coil construction. Coordination of the Design Study and of the Management Task DS1. Coordination of the Tasks DS4 Materials aging and DS5 Rapid Cooling. Participant in the Task DS2, DS3 and DS6.
2	Radboud University, High Field Magnet Laboratory, Nijmegen, the Netherlands	RU/ HFML	Large user facility for continuous and pulsed high magnetic fields, with DC and pulsed power supplies. Coordination of the Task DS6 Multi-coils. Participant in DS2.
3	Forschungszentrum Rossendorf, Hochfeldlabor Dresden, Dresden, Germany	FZR/ HLD	Large user facility for pulsed magnetic fields, with world's largest generator, under construction. Coordinator of the Tasks DS2 Modelling and DS3 Coil Monitoring. Participant in DS5 and DS6.
4	University of Oxford, Nicholas Kurti Laboratory	UOXF-DK	Facility for continuous and pulsed magnetic fields, responsable for explo-vessel testing and vacuum impregnation. Participant in DS2, DS4, DS5 and DS6

4 Implementation plan

The main objectives of this Design Study are to improve field strength, lifetime and reliability of pulsed user magnets, and to enhance the user operation of the infrastructures of the participants. They will be achieved by the implementation of 6 main tasks described below. Each of these tasks will be coordinated by one of the partners, under the central coordination of the CNRS-LNCMP, but will involve contributions from several partners.



Pert diagram of the different tasks and the flow of information between them.

4.1 List of tasks

Task number	Descriptive title	Leading participant	Short Description of the task
DS1	Management of DeNUF	CNRS-LNCMP	DS1 will coordinate and verify all other tasks, will handle all financial aspects and will be the interface with the Commission and the general public.
DS2	Modelling and data base	FZR-HLD	DS2 will start with acquisition of modelling and database software, followed by creation of the tailored add-ons and filling the database. The remaining time, this task will do specific modelling work and database updating, receiving feedback and data from the tasks DS3, DS4, DS5 and DS6, and providing these tasks with designs and interpretations.
DS3	Coil monitoring	FZR-HLD	DS3 will design, construct and validate coil monitoring systems to study aging and predict coil failure and will execute test programs with these systems.
DS4	Materials aging	CNRS-LNCMP	DS4 will start with specifying test conditions, followed by building of test setups, and then executing test programs to study aging effects in pulsed coil materials.
DS5	Rapid cooling	CNRS-LNCMP	DS5 will investigate appropriate rapid cooling techniques. It will design, construct and test rapid cooling prototype coils
DS6	Multi-coils	RU-HFML	DS6 will determine optimization criteria, analytic calculations of optimal parameter distributions, followed by detailed computer modelling, manufacturing and testing of prototypes. This task will also define safe operating conditions for multi-coil systems and examine industrial participation in the production of the large quantities of ultrastrong conductors needed for the outer coils.

4.2 Implementation plan

Task	Description Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	24	30	36	42	48
DS1	**Management of DeNUF**																							
A1.1	Overall management/communication																							
A1.2	Setting up intra- and internet web sites																							
A1.3	Updating intra- and internet web sites																							
	Deliverables																							
D1.1	Status reports and implementation plans		x										x							x		x		
D1.2	Intra- and internet web sites				x																			
D1.3	Task progress reports						x						x						x	x	x	x	x	x
D1.4	Proposal European pulsed infrastructure																							x
D1.5	Final report																							x
	Milestones																							
M1.1	Kick-off meeting		x																					
M1.2	CB meetings							x						x					x	x	x	x	x	x
M1.3	Plenary meetings													x						x		x		x
DS2	**Modelling and Data base**																							
A2.1	Analytic modelling																							
A2.2	Evaluation modelling/database software																							
A2.3	Updating materials database																							
A2.4	Development of software add-ons																							
	Deliverables																							
D2.1	Common basic modelling					x																		
D2.2	Thermal and cooling extension												x											
D2.3	Multi-coil extension												x											
D2.4	Periodic task progress reports						x						x						x	x	x	x	x	x
D2.5	Complete materials database																							x
D2.6	Final report																							x
	Milestones																							
M2.1	Materials database operational					x																		
M2.2	First version customised modelling									x														
M2.3	Validation customised modelling code												x											
M2.4	First validation monitoring results																		x					

Task	Description Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	24	30	36	42	48
DS3	**Coil monitoring**																							
A3.1	Design fiber sensor monitoring (FSM)																							
A3.2	Construction and testing FSM prototype																							
A3.3	Design acoustic/acceleration monitoring (AAM)																							
A3.4	Construction an testing AAM prototype																							
A3.5	Running coil tests with FSM and AAM																							
	Deliverables																							
D3.1	Prototype FSM + evaluation report															x								
D3.2	Prototype AAM + evaluation report															x								
D3.3	Coil monitoring reports																				x			x
D3.4	Periodic task progress report						x						x						x	x	x	x		
D3.5	Final report																							x
	Milestones																							
M3.1	Completion of monitoring systems															x								
M3.2	First in-situ coil deformation measurement																		x					
DS4	**Materials aging**																							
A4.1	Defining measurement protocol																							
A4.2	Construction of aging/impregnation setups																							
A4.3	Aging measurements																							
A4.4	Modelling aging effects																							
	Deliverables																							
D4.1	Aging measurement protocol							x																
D4.2	Aging measurement setup												x											
D4.3	Cryogenic explo-vessel setup															x								
D4.4	Large volume impregnation setup																		x					
D4.5	Periodic task progress reports						x						x						x	x	x	x	x	x
D4.6	Final report																							x
	Milestones																							
M4.1	Definition of aging setups							x																
M4.2	Completion of aging setups												x											
M4.3	First results aging study																			x				

Task	Description Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	24	30	36	42	48
DS5	**Rapid cooling**																							
A5.1	Basic tests on pulsed coil cooling																							
A5.2	Designing rapid cooling coils																							
A5.3	Construction/testing rapid cooling coils																							
	Deliverables																							
D5.1	Periodic task progress reports						x						x						x	x	x			
D5.2	Report on cooling techniques												x											
D5.3	Cryo test facility						x																	
D5.4	First rapid cooling prototype																		x					
D5.5	Advanced rapid cooling prototypes																							x
D5.6	Final report																							x
	Milestones																							
M5.1	Completion cooling measurement setup												x											
M5.2	Completion first rapid cooling prototype																		x					
M5.3	Start test rapid cooling prototype user coil																					x		
DS6	**Multi-coils**																							
A6.1	Analytic modelling multi-coils																							
A6.2	FEA modelling multi-coils																							
A6.3	Failure and safety research																							
A6.4	Construction and test of multi-coils																							
	Deliverables																							
D6.1	Preliminary designs multi-coils											x												
D6.2	Industrial participation report																		x					
D6.3	Multi-coil prototypes																							x
D6.4	Periodic task progress reports						x						x						x	x	x	x	x	x
D6.5	Final report																							x
	Milestones																							
M6.1	Definition multi-coil aspects DS2				x																			
M6.2	First multi-coil prototype test																		x					
M6.3	Start test user prototype multi-coils																					x		

4.3 Description of tasks

Task number	**DS1**	**Task title**	**Management and coordination**	
Start month: 1			**End month : 48**	
Participant number		1		
Participant short name		**CNRS**		**Total**
Person months		**17**		**17**

Objectives:
The objective of this task is to ensure the overall coordination of the project in all its administrative and scientific and technical aspects .

Description of work:
The Coordinator will ensure
1) the overall management tasks, in particular, the organisation of the annual plenary meeting and other project meetings (A1.1).
2) the setting-up and updating of intranet and internet web sites, both for communication within the consortium and towards the general public (A1.2 and A1.3).
3) the preparation of the different reports.
4) the elaboration of a detailled proposition for a formal distributed European pulsed magnetic field infrastructure.

The Coordinator will be assisted in this management task by a Coordinator Board and by the Task Leaders as described in section 5.1

Milestones, deliverables and expected result of this task :
The management task will ensure an efficient use of the resources, in order to realise all the deliverables of DeNUF on time and a wide dissemination of the results within the consortium and towards the Commission Services and the general public.

Deliverable number	**Deliverables**	**Dissemination level**
D1.1	Status reports and implementation plans (R)	PU
D1.2	Intra- and internet web sites (O)	PU
D1.3	Task progress reports (R)	CO
D1.4	Proposal European pulsed infrastructure (R)	PU
D1.5	Final report (R)	PU

R=Report, P=Prototype, O=Other. Dissemination level: PU=Public, PP= Restricted to specified groups (including the Commission Services), CO= Confidential, only for participants (including the Commission Services).

Milestone number	**Milestone description**	**Realisation month**
M1.1	Kick off meeting	2
M1.2	Coordination board meetings	Every 6th month
M1.3	Plenary meetings	Every 12th month

Task number	DS2	Task title	Modelling and database			
Start month: 1			End month : 48			
Participant number *		3	1	2	4	
Participant short name		FZR	CNRS	RU	UOXF	Total
Person months**		48	24	24(12)	7(5)	103

*task coordinator listed first, ** in parenthesis the additional staff effort in person months for the AC contractors.

Objectives:

DeNUF will develop a common software platform for pulsed coil finite element analysis (FEA) on the basis of commercial programs and a common materials database with relevant parameters for pulsed coil design. These tools will be used in everyday coil design, and in several of the other tasks of DeNUF.

Description of work:

Engineers and scientists of all the participants will form a distributed modelling group, with common software tools, materials database and coil benchmarks. This group, with its center of gravity at the FZR, will develop common analytic modelling approaches (A2.1), will select modelling and database software (A2.2), will develop the necessary add-ons for the specific needs of DeNUF (A2.4), and will fill the database (FZR, CNRS, RU, UOXF) (A2.3). It will complement the traditional codes in a modular way in order to include several alternative models. This will allow the participants to include different design approaches, to exchange and share results of simulations and to avoid duplication of work. We will use commercial programs like FEMLAB and ANSYS as a common platform for pulsed coil FEA. In particular we will study with FEA:

- distribution and evolution of stresses (pre-stress, thermal stress, magnetic stress, etc.) (RU);
- behaviour of the wire in the plastic regime, work hardening, coil fatigue properties (CNRS)
- optimisation of layer to layer transitions, coil flanges and coil connectors (FZR);

This task will also be heavily sollicited to provide designs and understanding for the DeNUF tasks Coil monitoring (DS3), Materials aging (DS4), Rapid cooling (DS5) and Multi-coils (DS6). Personnel will be exchanged for extended periods where necessary.

Milestones, deliverables and expected result of this task :

This task will create a common, distributed modelling platform/group with the corresponding materials database that will allow high performance modelling of pulsed coils.

Deliverable number	Deliverables	Dissemination level
D2.1	Common basic modelling (O)	PP
D2.2	Thermal and cooling extension (O)	PP
D2.3	Multi-coil extension (O)	PP
D2.4	Periodic task progress reports (R)	PP
D2.5	Complete materials database (O)	PP
D2.6	Final report (R)	PU

R=Report, P=Prototype, O=Other. Dissemination level: PU=Public, PP= Restricted to specified groups (including the Commission Services), CO= Confidential, only for participants (including the Commission Services).

Milestone number	Milestone description	Realisation month
M2.1	Materials database operational	5
M2.2	First version customised modelling	9
M2.3	Validation customised modelling code	12
M2.4	First validation monitoring results	18

Task number	**DS3**	**Task title**	**Coil monitoring**		
Start month: 1			**End month : 48**		
Participant number *		**3**		**1**	
Participant short name		**FZR**		**CNRS**	**Total**
Person months		**36**		**24**	**60**

*task coordinator listed first

Objectives:

DeNUF will develop techniques and prototypes to monitor the in-situ real-time deformation of pulsed coils during operation, in order to obtain information needed to improve coil performance and to estimate remaining coil lifetime.

Description of work:

DeNUF will develop two innovative technologies for in-situ, real time coil monitoring:
1) Fiber-optic strain gauges for use inside pulsed magnetic field coils (CNRS). This approach will rely on fiber Bragg sensors with the accompanying rapid readout systems. In DeNUF, miniaturized fiber sensors for incorporation inside the pulsed coils will be developped (A3.1) as well as fast optical readout systems, that will allow to record stresses at several positions inside the magnet during a field pulse. A working prototype of such a system will be constructed and and its evaluation will be reported (A3.2).
2) Accelerometers and microphones will be used to obtain reliable indicators of coil status and imminent coil failures (FZR) Related techniques used in industry to monitor machines and constructions will be adapted (A3.3) to determine when the coils are close to the end of their lifetime. A working prototype of such a system will be constructed and its evaluatuation will be reported (A3.4).
The two prototypes will then be used in coil tests, the results of which will be interpreted in close collaboration with the coil modelling task DS2 and reported (A3.5). Personnel will be exchanged for extended periods where necessary.

Milestones, deliverables and expected result of this task :

This task will provide new coil monitoring techniques and prototypes that allow to obtain deeper understanding of the behaviour of pulsed coils and that can serve as early warning system for coil failure.

Deliverable number	Deliverables	Dissemination level
D3.1	Prototype FSM + evaluation report (P)+(R)	PU
D3.2	Prototype AAM + evaluation report (P)+(R)	PU
D3.3	Coil monitoring results (R)	PU
D3.4	Periodic task progress report (R)	PP
D3.5	Final report (R)	PU

R=Report, P=Prototype, O=Other.Dissemination level: PU=Public, PP= Restricted to specified groups (including the Commission Services), CO= Confidential, only for participants (including the Commission Services).

Milestone number	Milestone description	Realisation month
M3.1	Completion of monitoring prototypes	15
M3.2	First in-situ coil deformation measurement	18

Task number	**DS4**	**Task title**	**Materials aging**		
Start month: 1			**End month : 48**		
Participant number *		**1**		**4**	
Participant short name		**CNRS**		**UOXF**	**Total**
Person months**		**36**		**30(9)**	**66**

*task coordinator listed first. ** in parenthesis the additional staff effort in person months for the AC contractor.

Objectives:

DeNUF will set up a systematic test and characterisation program of the aging of the mechanical and electric properties of the different materials used in pulsed coil fabrication under realistic operation conditions. The objective of this task is twofold; by better understanding the materials aging mechanisms in pulsed coils, they can be reduced by changing the design or material choice, thereby improving the average lifetime of pulsed magnets. Such an understanding will furthermore allow us to reliably estimate the remaining lifetime of the pulsed coil.

Description of work:

The task will start by defining a measurement protocol, by establising which material parameters are crucial in coil aging, how to quantify them and under which conditions (CNRS) (A4.1). Next, conductor, insulator and support material aging measurement setups will be constructed (CNRS and UOXF) and used in order to characterise materials that are already in use in pulsed coil construction under realistic conditions (low temperature, shock-like loading) (A4.2). As a first attempt to reduce aging, a study of the effect of impregnation on coil aging will be performed, after the corresponding large volume impregnation setup has been completed (UOXF) (A4.2). In addition, these setups will allow to identify new, improved materials. These measurements will include different types of deformation measurements (cryogenic in-situ (CNRS), by means of an explo-vessel (UOXF) and post-mortem (CNRS)) to study (A4.3) and model (A4.4) the relation between deformation and aging. Personnel will be exchanged for extended periods where necessary.

Milestones, deliverables and expected result of this task :

This task will provide understanding of aging phenomena in pulsed coils, which will be used to improve coil lifetime, reliability and predictability and to allow optimal use of the resources whilst providing maximum access to the users.

Deliverable number	**Deliverables**	**Dissemination level**
D4.1	Aging measurement protocol (R)	PU
D4.2	Aging measurement setup (P)	PU
D4.3	Cryogenic explo-vessel setup (P)	PU
D4.4	Large volume impregnation setup (P)	PU
D4.5	Periodic task progress reports (R)	PP
D4.6	Final report (R)	PU

R=Report, P=Prototype, O=Other. Dissemination level: PU=Public, PP= Restricted to specified groups (including the Commission Services), CO= Confidential, only for participants (including the Commission Services).

Milestone number	**Milestone description**	**Realisation month**
M4.1	Definition of aging setups	7
M4.2	Completion of aging setups	12
M4.3	First results aging studies	24

Task number	**DS5**	**Task title**	**Rapid cooling**		
Start month: 1			**End month : 48**		
Participant number*		**1**	**3**	**4**	
Participant short name		**CNRS**	**FZR**	**UOXF**	**Total**
Person months**		**36**	**48**	**14(4)**	**98**

*task coordinator listed first. ** in parenthesis the additional staff effort in person months for the AC contractor.

Objectives:
DeNUF will develop rapid cooling technology for pulsed magnetic fields coils by introducing efficient cooling pathways inside coils in order to significantly reduce the cooling time. This will allow more measurements to be performed in a given time.

Description of work:
This task will start by basic tests of how pulsed coils cool when immerged in liquid nitrogen (A5.1). Based on the reports resulting from these tests, cryo-cooling measurement setups will be designed (UOXF) and constructed. Two main mechanisms will be investigated and reported on, cooling through low temperature gaseous nitrogen and liquid nitrogen (CNRS) and cooling by solid state heat conduction (FZR). Based on this information, new coils will be designed (A5.2) that have a greatly improved cooling rate, in collaboration with the modelling task DS2. Prototypes according to these designs will be constructed and tested (CNRS and FZR). Based on these test results, construction and tests of rapid cooling prototype user coils will be performed (CNRS and FZR) and reported (A5.3). Personnel will be exchanged for extended periods where necessary.

Milestones, deliverables and expected result of this task :
This task will provide understanding of improved cooling of pulsed coils, and corresponding designs and prototypes for rapid cooling coils.

Deliverable number	Deliverables	Dissemination level
D5.1	Periodic task progress reports (R)	PP
D5.2	Report on cooling techniques (R)	PP
D5.3	Cryo test facility (P)	PU
D5.4	First rapid cooling prototype (P)	PU
D5.5	Advanced rapid cooling prototypes (P)	PU
D5.6	Final report (R)	PU

R=Report, P=Prototype, O=Other. Dissemination level: PU=Public, PP= Restricted to specified groups (including the Commission Services), CO= Confidential, only for participants (including the Commission Services).

Milestone number	Milestone description	Realisation month
M5.1	Completion of cooling measurement setup	12
M5.2	Completion of first rapid cooling prototype	18
M5.3	Start test of first rapid cooling user coil	36

Task number	**DS6**	**Task title**	**Multi coils**			
Start month: 1			**End month : 48**			
Participant number*		**2**	**1**	**3**	**4**	
Participant short name		**RU**	**CNRS**	**FZR**	**UOXF**	**Total**
Person months **		**84(36)**	**48**	**48**	**10(4)**	**190**

*task coordinator listed first. ** in parenthesis the additional staff effort in person months for the AC contractor.

Objectives:

The multi-coil task will optimize the design for the most performant, cost effective and safe multi-coil systems for the different infrastructures of the three major participants and will construct and test the corresponding prototypes.

Description of work: This task has two main subtasks

a) Optimizing the design for the most robust and cost effective multi-coil systems for the different infrastructures of participants 1,2 and 3, and determine how the repartition between the optimized sub-coils should be made in the most efficient way (RU). This will intrinsically be done in close collaboration with the modelling task DS2. In view of the large size of the outer coil, and its long cool down time, there is also a strong coupling of this aspect to the rapid cooling task DS5.

b) Safety analysis of the interaction of the nested coils and investigation of the failure modes. In the not-so-improbable event of the destruction of the innermost coil, the user and the other parts of the system, like the massive (and therefore expensive) outer coil and its power supply must be adequately protected against high voltage flash-overs and high speed debris (RU).

The task will be based on the pre-existing know-how in analytic and finite element modeling of pulsed magnet coils (CNRS, RU, FZR). It will start with analytic modelling (A6.1) whereas at the same time, the software tools for FEA modelling will be updated and activated as part of task DS2 (RU, FZR, CNRS). The FEA modelling will produce design guidelines on multi-coils with optimal performance for the energy sources available at the different infrastuctures of the participants (A6.2). DS6 will study and report the failure and safety aspects of these multi-coils (A6.3). This will give a sound basis for the manufacturing of three prototype coils (RU, CNRS, FZR) (A6.4). In view of the size of the outer coils, quantities of ultrastrong conductor that are beyond laboratory scales will probably be needed for prototype construction. Therefore a study into industrial involvement in the production of such conductors will be made (UOXF).

Personnel will be exchanged for extended periods where necessary.

Milestones, deliverables and expected result of this task :

This task will provide designs, safe operating protocols and prototypes of pulsed multi-coil user magnets.

Deliverable number	Deliverables	Dissemination level
D6.1	Preliminary designs multi-coils (O)	PP
D6.2	Industrial participation report (R)	PP
D6.3	Multi-coil prototypes (P)	PU
D6.4	Periodic task progress reports (R)	PP
D6.5	Final report (R)	PU

R=Report, P=Prototype, O=Other. Dissemination level: PU=Public, PP= Restricted to specified groups (including Commission Services), CO= Confidential, only for participants (including Commission Services).

Milestone number	Milestone description	Realisation month
M6.1	Definition of multi-coil aspects of modelling task DS2	4
M6.2	First multi-coil prototype test	18
M6.3	Start test multi-coil user prototypes	36

5 Consortium management activities

5.1 Organisational structure and overall project management

5.1.1 Structure

The management structure has been established to ensure efficient and effective management of the operational, technical and financial aspects of the DeNUF Design Study. It includes the Coordinator, a Coordination Board and the Task Leaders.

The **Coordinator** is responsible for the administrative coordination of the contract through its administrative department. He is also responsible for the scientific and technical coordination of the project through the director of the LNCMP, who is assisted in this task by a Coordination Board (CB).

The **Coordination Board (CB) will be** headed by the Coordinator. It also includes one repesentative per participant. The CB will be in charge of all decisions relevant to the project, such as, but not limited to :

-approval of the annual reports and of annual implementation plans,
-approval of financial and time planning,
-guaranteeing adequate administrative and scientific project controlling with respect to deliverables, milestones and reports,
-taking care of financial, budgetary, time planning and contract matters,
-monitoring and coordination of the flow of information within the consortium,
-dissemination and management of knowledge.

Weekly contacts will be implemented among the members of the CB. The CB will meet twice a year.

Each task will have a **Task Leader (TL)** who will be responsible for the coordination and realisation of the work plan of his/her Task, the flow of information and human resources between the participants of the task, for monitoring progress towards milestones and for reporting to the Coordinator and the Coordination Board. In particular, the exchanges of personnel within a given task will be coordinated by the Task leaders. Each Task Leader will have regular contacts with all the members of his/her task and with the Coordination Board.

Each task will have regular meetings twice a year, organized by the Task Leader, and meetings on specific topics, that may be called by any participant of the task when the need arises.

The Coordination Board will appoint external experts if required, upon recommandation of the Task Leaders, in order to provide top-level guidance to the DeNUF consortium on specific topics and on actions that are relevant to the needs of the research in high magnet fields.

5.1.2 Tools for communication and progress monitoring

Communications between participants will involve exchanges by e-mail, telephone and video conference meetings and the Intranet site. **Projects meetings** will be one of the major instruments for monitoring and coordinating the project.

The main tool that will be used to coordinate activities will be an **Intranet web site** that will be implemented and updated continuously. Internal components of the DeNUF web-site will be accessible only for the DeNUF partners and to the European Commission, and will serve to manage the project by providing all relevant information on administrative and scientific issues. For communication outside the DeNUF collaboration, an **Internet web site** will be used (e.g. for hiring, popularisation). Moreover, for all tasks, **exchanges of personnel for extended periods** are planned to improve interactions and communications.

Each Task leader will provide to the Coordination Board via the Coordinator every 6 months a periodic **activity report** containing the progress towards the planned deliverables and the work plan

for the next 6 months. Many of the tasks have progress reports as deliverables, which will also disseminate information between the participants.

A **consolidated report** on each one-year period will be set up by the Task 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 concerned period and the updated implementation plan for the next 12 months.

The Coordination Board and 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.

5.2 Potential impact and risks assessment

The success of the different tasks and the impact of the Design Study as a whole can be monitored in terms of the increase in field strength and coil lifetime, and the reduction of the cooling time that has been realized in the test and prototype coils with respect to the current situation. This in turn should lead to an better use of the facilities, visible as an increase in the number of users and experiments at these facilities. As all partners of DeNUF are also partners in the Integrated Infrastructure Initiative EuroMagNET (506239, starting date 1/1/2005), the entire European high field user community can benefit from the progress realised by DeNUF.

The risks that could delay a successful realisation of the various tasks differ from task to task. The modelling task involves identifying for all participants the most suitable commercial software, followed by modular improvements and represents therefore no significant risk. The same holds for the coil monitoring task, that will adapt existing technologies developped in other contexts, to the specific conditions of pulsed coil operation. The materials aging task is guaranteed to provide data on the behaviour of conductors and insulators under typical coil operation conditions. Whether these data can be understood or modelled is less certain. Whether materials aging can be strongly reduced or better insulators can be found is an open question. The large experience in metallurgy present among the participants does provide a good basis for a successful completion of also this aspect of the task. Simulations performed at the CNRS-LNCMP, and unpublished results from the pulsed field facility of the University of Amsterdam and of the NHMFL pulsed field facility suggest that big improvements in the cooling rate of pulsed coils can be realized. Finally, the results obtained from the ARMS project and its continuation in Toulouse, and the modelling work under way at the FZR-HLD and the NHMFL suggest that further progress can be realized with the multi coil approach.

5.3 Plan for use and dissemination of knowledge

The results of the Design Study will be essential to the progress in magnet performance that can be realized collectively by the participants and the improvement of the amount and the quality of the access they can provide to European users for performing scientific experiments. It will open field ranges not previously accessible, which enable new experiments that are currently not possible anywhere in the world.
When possible, jointly owned patents or copyrights will be secured and licenses will be granted to companies interested in commercialising the results. Most other results of the Design Study will be published in the open literature and presented at the appropriate international conferences, so that other pulsed magnet laboratories can also benefit from them and improve their performance and efficiency. Access to the software tools and database will also be granted to other european laboratories interested in using or producing pulsed magnetic fields. Through the close interaction realised between all european high field laboratories by the Integrated Infrastructure Initiative EuroMagNET (506239, starting date 1/1/2005), dissemination of the DeNUF results towards these other laboratories will be almost automatic.

Some results of the Design Study, that could give the four partner collective leverage in collaborations or technology exchanges with the NHMFL and other major non-European pulsed field facilities, will be kept confidential.

6 Project resources and budget overview

6.1 Total effort in person months needed for the full duration of the project

Task	CNRS	RU	FZR	UOXF	Total
DS1	**17**	**-**	**-**	**-**	**17**
DS2	**24**	**24(12)**	**48**	**7(5)**	**103(17)**
DS3	**24**	**-**	**36**	**-**	**60**
DS4	**36**	**-**	**-**	**30(9)**	**66(9)**
DS5	**36**	**-**	**48**	**14(4)**	**98(4)**
DS6	**48**	**84(36)**	**48**	**10(4)**	**190(40)**
Total	**168**	**108(48)**	**180**	**61(22)**	**517(70)**

*in parenthesis the additional staff effort in person months for AC contractors

6.2 Description of other resources needed

Other ressources needed are travel expenses, audit certificats, materials, consumables and small equipement, and computer hardware and software. No large equipement is requested and no subcontract is planned.
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6.3 Overal budget for the full duration of the project

Forms A3.1 and A3.