ANNEX I

LIST OF PARTICIPANTS AND DESCRIPTION OF WORK

Network Title: European Investigations on DAPHNE and other International Collider Experiments using Effective Theories of Colours and Flavours for high precision elementary particle physics from the phi to the Upsilon.

Network Short Title: EURIDICE

Part A - The Participants

The Principal Contractor and the Members listed below shall be jointly and severally liable in the execution of work defined in Part B of this Annex :

The Principal Contractor

1. Istituto Nazionale di Fisica Nucleare, Frascati National Laboratories, [INFN-LNF] established in Italy

The Members

2 University of Valencia [UVEG] established in Spain
3 Universitat Autonoma de Barcelona [UAB] established in Spain
4 CNRS-CPT Luminy, Marseille [CNRS-DR12] established in France
5 CNRS - Institut National de Physique Nucleaire et de Physique des Particules [CNRS/IN2P3] established in France
6 Universiy of Durham [DUR] established in the United Kingdom
7 University of Lund [ULUND]established in Sweden
8 University of Helsinki [UHELS] established in Finland
9 DESY Zeuthen [DESY Zeuthen] established in Germany
10 University of Bern [UNIBE]established in Switzerland
11 Universitat Wien [UWIEN.ITP] established in Austria
12 Warsaw University [Warsaw] established in Poland

The Principal Contractor and the Members are referred to jointly as “the Participants”.

Part B - The Joint Programme of Work

1 Project Objectives

The project focuses on a precise determination of masses, coupling constants and order parameters in the Standard Model. Specifically, the major theoretical and phenomenological objectives of this project can be grouped into six main research lines of investigation which will be described in what follows.

1. **CP- violation and Cabibbo-Kobayashi-Maskawa (CKM) matrix** will be the object of investigations

- To help clarify the origin of CP violation
- To investigate Quantum Mechanics (QM) entanglement and its role in fixing CP-violation parameters :
- To improve the theoretical precision for the CKM matrix
- To improve the understanding of rare kaon decays

2. **Chiral Perturbation Theory** (ChPT) will be studied

- To sharpen existing predictions
- To determine effective low-energy couplings from first principles
- To investigate the evolution of Chiral Symmetry Breaking (ChSB) with number of light flavours N_f and number of colours N_c
- To investigate the order parameters of QCD
- To investigate the role of Chiral symmetry in baryon ChPT and Hypernuclei

3. **Quark mass-determinations** will be improved both from dispersive sum rules and from spectral-function measurements. ChPT calculations will be performed, to estimate isospin breaking effects to higher precision, including reanalysis of relevant electromagnetic effects.

4. **$\alpha_{em}(M_Z)$ and the anomalous magnetic moment of leptons** will be studied

- To improve the calculation of the shift in the fine structure constant
- To improve the calculation of the hadronic contributions to anomalous magnetic moments and assess the precision of Standard Model predictions

5. **Heavy flavour decays and Heavy Quark Effective Theory (HQET)** will be studied, analyzing data from several experiments like BABAR, BELLE, BTeV, CESR-C, FOCUS, HERA-B, LHC-B, SELEX, etc

6. **Strong Interaction limit of QCD** will be studied

- Through the behaviour of α_s in the infrared region
- To firmly establish the new glueball spectroscopy
- To determine glue and flavour content of the low lying scalar multiplets.
- To clarify the effect of strong interactions in heavy flavour decays

2 Research Method

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To study elementary particle interactions with high precision in a region where the traditional tools of perturbative QCD are of limited use, various theoretical tools will be employed, which can be grouped under the term *Effective Theories of Colours and Flavours* . The phenomenological applications of these theories will concern the study of pion, kaon, charm and bottom interactions, meson, baryon and hyperbaryon spectroscopy, hadronic cross-sections, forms factors in space- and time-like region. The data will include output from all the low and intermediate energy experiments, like KLOE and DEAR at DAPHNE, WASA, NA48, DIRAC, Babar, BELLE, CESR-C, FOCUS, SELEX, B-TeV, HERA-B, LHC-B.
The theoretical methods will include: Chiral Perturbation Theory , Large-N_C expansion, Heavy Quark Effective Theory , Exact renormalization group, QED and Perturbative QCD , Quantum Mechanics. *Chiral Perturbation Theory* will be used to investigate isospin violation in semileptonic and nonleptonice kaon decays, hadronic atoms, triple chiral logs, extrapolation of lattice data for large quark masses to the physical values. The low-energy realization of the four-fermion weak Hamiltonian will be applied in the analysis of nonleptonic and radiative kaon decays to extract several next-to-leading order couplings of the theory which have not yet been determined. New techniques to calculate electroweak transitions between Goldstone

particles which are formulated within the framework of the *1/ N_C -expansion in QCD* will be used to investigate observables like f_B or $m(B^{\pm})$-$m(B^0)$ and such as the matrix elements involved in $B^0_{(s)}$- $B^0_{(s)}$bar mixing.. The strong interactions of heavy quarks (b,c) can be treated with an effective field theory, the *Heavy Quark Effective Theory* (HQET). The following techniques will be utilized to investigate the various questions arising from B-physics experiments and their interpretation : Sum Rules for subleading corrections in HQET, duality and OPE in potential models, Bakamjan-Thomas models, and Large Energy Effective Theory (LEET). *Wilsonian Renormalization Group* (RG) techniques can be expected to bring progress in the study of infrared properties of QCD, such as Chiral Symmetry Breaking (ChSB). This method could be particularly suitable for studying phase transitions as a function of N_f , N_C and temperature. For precision measurements in e^+e^- collisions, *QED radiative corrections* will be dealt with standard leading and next-to-leading-order corrections to second order of QED, leading logarithmic approximation and Monte Carlo event generators for data analysis and simulations. Monte Carlo simulations and soft photon summation techniques will also be applied. The problem of the infrared behaviour of the strong coupling constant $\alpha_s(s)$ will be investigated through two different approaches, that of *Soft Gluon Summation techniques a' la Bloch-Nordsieck* and lattice QCD. Spectroscopy issues, scalar mesons, hybrids and scalar glueballs will be attacked with a variety of theoretical techniques. In particular, to study the light scalars of the meson spectrum effective theories with the same symmetries as QCD will be used. To study heavy mesons, a systematic study of the hadronic and electromagnetic decay modes of heavy quarkonia and heavy-light meson resonances will be undertaken, using an *interaction Hamiltonian* modelled on the known heavy quark interaction and the instanton induced interaction. To investigate decoherence effects in two-meson systems, deviations from QM will be parametrized with a *decoherence parameter* to have a measure for how the system is away from total decoherence. For the same purpose, the quantum mechanical time evolution will be modified with a dissipative term.

3. **Work Plan**.

To reach the objectives of this project, the work plan will be structured around **Working Groups** and **Tasks Assignments**.

At the beginning of the project, the following Working Groups will be established :

i) CP-violation in K-, D- and B-mesons,

ii) B-physics,

iii) π K system, hadronic atoms,

iv) hadronic cross-sections and $(g-2)_\mu$,

v) total cross-sections,

vi) scalar mesons and glueballs,

vii) hypernuclear topics and ChPT.

Each team will be concerned with accomplishing a number of tasks towards the attainment of the stated objectives. The tasks have been divided into three main groups

- *Theoretical developments in Effective Field Theories* mainly concerned with objectives in Chiral Perturbation Theory
- *Theoretical and phenomenological studies* of data from precision experiments mainly concerned with theoretical estimates or modeling of physical quantities like decays, cross-sections, form factors, and with spectroscopy issues
- *Future experiments and identification of relevant hadronic quantities* concerned with preparation of the theoretical grounds for future experiments, or phenomenological extraction of precision data.

Within these main lines, there are a series of specific tasks to which groups of physicists in the various teams will contribute. We indicate in 3 tables, one for each area, the specific tasks and the participant teams which will be working on those tasks.
Six months after the start of the contract, a Network Meeting will be organized to start the Working Groups mentioned at the beginning. The Working Groups will meet at least twice a year, once separately and once together at the Network Meetings, held once a year. The contribution of each of the young researchers to the development of these tasks will be indicated at the time of the Midterm Report.

1. Theoretical developments in Effective Field Theories								
Participant	Quark masses	ChPT 3 flavour	Isospin Breaking Effects	Large N_C QCD	N_f / N_C dependence	Lattice QCD and ChPT	HQET and LEET	EFT in Nuclear Matter
1. INFN-LNF			*				*	*
2. UVEG	*	*	*	*		*	*	*
3. UAB		*		*	*			
4. CNRS- DR12		*	*	*		*	*	
5. CNRS/IN2P3	*	*	*	*	*		*	
6. DUR	*		*					*
7.ULUND	*	*	*	*		*		
8.UHELS	*	*	*					
9. DESY Zeuthen	*		*			*		
10.UNIBE	*	*	*	*		*		
11.UWIEN.ITP		*	*					
12.Warsaw		*	*					

2. Theoretical and phenomenological studies							
Participant	CP CPT QM	CKM Matrix	Rare K-decays	Charm and beauty decays	$(g-2)_\mu$ and $\alpha_{QED}(M_Z)$	α_S in infrared	Glueball spectroscopy
1.INFN-LNF	*	*	*	*	*	*	
2.UVEG	*	*	*	*	*		
3.UAB	*	*	*	*			
4.CNRS -DR12	*	*	*	*	*		
5.CNRS/IN2P3	*	*	*	*			
6.DUR				*	*	*	*
7.ULUND	*	*	*	*			
8.UHELS				*			*
9.DESY Zeuthen					*		
10.UNIBE	*	*	*		*		
11.UWIEN.ITP	*	*	*		*		
12.Warsaw	*		*	*	*		*

3. *Future experiments and identification of relevant hadronic quantities*						
Participant	Hadronic Atoms at DEAR and DIRAC	η,η' at WASA and KLOE	MC and Rad. Corr. for σ_{had} at KLOE	τ-Charm factories	Kaon-Nucleon Scattering	Hypernuclei from FINUDA
1.INFN-LNF	*		*		*	*
2.UVEG				*	*	*
3.UAB		*		*	*	*
4.CNRS-DR12	*	*		*		
5.CNRS/IN2P3	*	*		*		
6.DUR				*	*	*
7.ULUND		*				
8.UHELS	*	*		*		
9.DESY Zeuthen			*			
10.UNIBE	*	*			*	
11.UWIEN.ITP				*		
12.Warsaw	*	*	*	*	*	

The young researchers' contribution towards the attainment of these objectives will be specified at the time of the Final Report.

- **Schedule and milestones**

Milestones in the project are indicated in the following table, with objectives and tasks explicitly named, according to definitions in sect.2 and 4. The horizontal arrows indicate when theoretical predictions or phenomenological estimates related to the stated objective or task will be available relative to the starting date of the contract.

Objective	Task	24 m	32 m	40 m	48m
CP and CKM	Rare K decays				
	CP,CPT,QM				
	CKM matrix				
ChPT I	ChPT with 3 flavours				
	EFT in nuclear matter				
	Isospin breaking effects				
ChPT II	Large Nc QCD				
	Lattice QCD and ChPT				
	N_f/ N_C dependence				
ChPT III	HadAtoms at DEAR and DIRAC				
	KN scattering				
	η,η’ at WASA and KLOE				
	Hypernuclei at FINUDA				
Quark masses					
$\alpha_{QED}(M_Z)$ and $(g-2)_\mu$	MC methods and Rad. Corr at KLOE				
	Hadronic contributions to $(g-2)_\mu$ and α_{em}				
Heavy flav. & HQET	HQET and LEET				
	Charm and beauty decays				
Strong QCD	α_S in infrared region				
	Glueball spectroscopy				

- **Research Effort of the Participants**

This network consists of 1 Coordinator and 11 Participants, of which 9 from Member States, 1 from an Associated State and 1 from Switzerland, with the Swiss participant from University of Bern directly funded from the Swiss government.

Professional research effort on the network project			
Participant	Young researchers to be financed by the contract (person-months) (a)	Researchers to be financed from other sources (person-months) (b)	Researchers likely to contribute to the project (number of individuals) (c)
1. INFN-LNF	48	155	30
2.UVEG	30	200	19
3.UAB	30	222	26
4.CNRS-DR12	24	80	12
5.CNRS/IN2P3	24	66	12
6.DUR	48	60	10
7.ULUND	13	53	6
8.UHELS	13	58	8
9.DESY Zeuthen	24	122	13
10.UNIBE	24	226	13
11.UWIEN.ITP	24	60	9
12.Warsaw	0	67	11
Totals	302	1369	169

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The network intends to have two subcontractors

- University of Oslo as subcontractor of University of Lund with maximum cost of 10700 EURO.
- University of Karlsruhe as subcontractor of the DESY-Zeuthen team with maximum cost of 15761 EURO.

4 Organisation and Management

- Coordination

The network activity will be coordinated through the scientist-in-charge of each participant node. This group of 12 scientists is hereafter referred to as the Team Committee. All communications to the network members will go from the Coordinator to each team through the scientist-in-charge in the Team Committee, who will be responsible for distributing such information to all the researchers belonging to his/her team. The methods, which will insure good communications between the research teams and for monitoring and reporting progress, will include electronic communications, person-to-person exchanges and the network meetings, general and topical. Electronic communications consist both of e-mail exchanges for the preparation of joint papers, or the yearly reports, and use of the web page http://www.lnf.infn.it/theory/rtn/ where news about interesting Conferences and Workshops will be posted, and meetings announced.

- Decision making

The network planning and the decision making process will rely upon the Executive Committee, consisting of the 15 scientists in charge of the nodes and subnodes, integrated by the monitor of progress in the area of B-physics research, and by the Data Analysis Coordinator in the KLOE experiment. The meetings of the Committee will be open to all the permanent staff belonging to the participant teams. The Committee will meet at least once a year, to monitor the progress of the network. It will meet soon after the beginning of the project to lay the rules for implementation of the work plan, and for the first round of selection of the young researchers. The Committee will have to approve formally the hiring of young researchers but this can also take place via electronic mail.

- Publications

The results of the network research will be submitted for publication to the International Journals. The network publications will be listed in the web page of the network, and linked to the preprint data bases at SLAC , Durham and at SISSA. The work of the network will be publicized also through the Collaboration Meetings open to external participants. These meetings will be announced in the major European Universities and Research Centers. After completion of the Contract, the network may hold a Final General Meeting with published proceedings to summarize and describe the results of the research project.

- International Conferences

A maximum of 2 conference participations outside the EU and Associated states for each participant, each involving up to 2 researchers for a maximum of 10 days, whereby not more than 3 researchers for the entire network, excluding young researchers, should take part in the same event, is deemed to be approved.

- Field trips

A maximum of 6 field trips to the Massachusetts Institute of Technology, in Cambridge, USA, and/or Thomas Jefferson Laboratory, USA, is deemed to be approved. These field trips are needed for essential consultations with international experts.

5 Training

- **Appointment of Young Researchers**

A minimum overall total of 302 person-months will be provided by young researchers whose employment will be financed by the contract.

Young researchers to be financed by the contract				
Participant	Young pre-doctoral researchers to be financed by the contract (person-months) (a)	Young postdoctoral researchers to be financed by the contract (person-months) (b)	Total (a+b) (c)	Scientific specialities in which training will be provided (d)
1. INFN-LNF	24	24	48	P01
2.UVEG		30	30	P01
3.UAB		30	30	P01
4.CNRS-DR12		24	24	P01
5.CNRS/IN2P3		24	24	P01
6.DUR	24	24	48	P01
7.ULUND		13	13	P01
8.UHELS		13	13	P01
9.DESY Zeuthen		24	24	P01
10.UNIBE		24	24	P01
11.UWIEN.ITP		24	24	P01
12.Warsaw		0		
Totals	48	254	302	

The 302 person-months of young researchers are divided among 48 person-months of pre-doctoral students and 254 person-months of post-doctoral researchers. Whenever possible, the typical length of these appointments is expected to be 24 months for the post-doctoral researchers, it may be less for the pre-doctoral students engaged in obtaining a Master degree, typically a 12 month period in the U.K. Vacancies in the network will be published at the Cordis site, and publicized through the particle physics community channels, notably the CERN theoretical physics listing. A list will also be sent to the website of other theoretical particle physics RTN networks.

The gender aspects of training in physics will be addressed by paying attention to the special problems which might be encountered by women applicants, in particular mobility related. In correspondence to the Pre-doc training offered by the network, a special effort will then be dedicated to advertise the positions with the graduating classes in the European universities, through dedicated means like posters and banners in the physics departments web-pages.

- **Training Programme**

The EURIDICE project aims at the training of young researchers in the field of hadronic physics, through the scientific and professional expertise provided by a network based on a well tested structure of international preexisting collaborations. The young researchers will be an integral part of this large and active network. Collaboration with expert scientists at the nodes will be at the core of the individual training. Network meetings will provide common training by learning from international experts and presenting in public one's own work. There will be topical workshops with limited attendance, where the young researchers can gain confidence by discussing the work, in which they have a unique expertise, in front of an audience of experts from the network. Young researchers will be encouraged to organize the Topical Workshops. The collaboration meetings with larger attendance, also from outside Europe, will keep the young researchers updated on current network physics issues and prepare young researchers for larger audiences. The LNF Spring school, started in 1995, attended in 2001 by young researchers from two EC networks, ESOP and EURODAPHNE, will play an important role in involving the young researchers in the management and organization of the mini-workshops on topical themes which are an integral part of the School program. Each year, under the advice of the network Executive Committee, the School will award 4 Fellowships to the most deserving young researchers of the network, with funds made available by the INFN-LNF coordinator team. Such costs are included in Networking Expenses, as specific Costs by Participant N. 1. Specific costs for other participants include attendance to Conferences and Workshops.
The training programme includes both post-doctoral researchers and doctoral students. The training programme will integrate the gender aspects by ensuring women participation in the network decision making process, guaranteed by the presence of four women in the Network Steering Committee of 17 members, namely the network coordinator, the scientist-in-charge of the Warsaw node, the scientist-in-charge of the Granada subnode and the analysis coordinator of the KLOE experiment (see Sect. on management).
The EURIDICE network will offer multidisciplinarity in the training programme, through close connection between experimental and theoretical research and between many different subjects like the proper foundations of all particle physics, quantum mechanics and EPR-related phenomena, nuclear physics and hadronic bound states, effective field theory techniques and lattice calculations. Access to technological excellence will be ensured by the contiguity of the training with frontier physics in accelerator and detector technology, both in Frascati, and in other European Laboratories producing the data to be analyzed by the network scientists.

The measures to be undertaken in the training program are divided among individual and common training and are summarized in the last table.

Type of Training	Planned Activities	Accompanying Measures
Individual Training	• Collaboration with team scientists on network projects • Collaboration with other YR on a joint research project with teams supervision • Course work for MSc students	• At least two seminars locally at beginning and end of training • Visits and secondments to other nodes and home institutions • Presentations at International Conferences
Common Training	• General Network Meetings (yearly) • Topical Network Workshops • LNF Spring School (yearly)	• Talks by YR • Involvement in organization and scientific planning