Fourth Periodic Report

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RTN NETWORK

EURIDICE

European Investigations on DAΦNE and other International Collider Experiments using Effective Theories of Colours and Flavours from the Φ to the ϒ

Fourth Periodic Report 01/09/2005 - 31/08/2006

Contents

1 A - RESEARCH RESULTS

The EURIDICE project focused on a precise determination of masses, coupling constants and order parameters in the Standard Model. The major theoretical and phenomenological objectives of EURIDICE, stated in Annex I of the contract, can be grouped into six main research projects, respectively:

1. **CP- violation and Cabibbo-Kobayashi-Maskawa (CKM) matrix**
   - *To help clarify the origin of CP-violation*
   - *CP violation and rare decays*
   - *Quantum mechanics and the neutral meson system*
   - *To improve the theoretical precision for the CKM matrix elements*
2. **Chiral Perturbation Theory**
   - *To determine effective low-energy couplings from first principles*
   - *To investigate the order parameters of QCD*
   - *Baryon ChPT and Hypernuclei*
3. **Quark masses**
4. $\alpha_{em}(M_Z)$ **and the anomalous magnetic moment of the leptons**
   - $(g-2)_\mu$ *and multi-loop calculations*
   - *Precision determination of electroweak parameters*
   - *The electroweak contribution*
   - *Hadronic Effects in electroweak precision observables*
5. **Heavy flavour decays and Heavy Quark Effective Theory (HQET)**
   - *D-decays*
   - *B-decays*
6. **Strong Interaction limit of QCD**
   - α_s *in the infrared region*
   - *Meson and baryon Spectroscopy beyond the naive Quark Model*
   - *New mesons and baryons*

In the sections to follow, the progress achieved towards attainment of these objectives during the fourth operating period will be discussed.

In the first section we shall list the most interesting results obtained by the network during the fourth year of operation. For each scientific highlight listed here, we indicate which node(s) participated to this research item and the bibliographic references.

1.1 A1. Scientific Highlights

1.1.1 CP- violation and Cabibbo-Kobayashi-Maskawa (CKM) matrix

To help clarify the origin of CP-violation

- The LNF node [1] has generalized, from the quark to the lepton sector, the so called Minimal Flavor Violation (MFV) hypothesis, which is one of the most attractive approaches to explain why we have not observed yet any deviation from the SM in CP-violating observables and rare decays, including a discussion on how this hypothesis can be implemented in Grand Unified theories.
- A collaboration between the DESY-Zeuthen and Marseille [2] nodes has provided results for the $\Delta S = 2$ matrix elements which are required to study neutral kaon mixing in the standard model (SM) and beyond (BSM), as well as leading chiral order results for the matrix elements of the electroweak penguin operators which give the dominant $\Delta I = 3/2$ contribution to direct CP violation in $K- > \pi\pi$ decays. As a by-product of this study, the strange quark mass is determined.
- A new calculation of the Kaon B_K parameter was performed by a Lund-UAB/Granada collaboration, within the hadronic ladder resummation. A Chiral Perturabtion Theory calculation was used to identify sources for large corrections when going beyond the chiral limit[3].

CP violation and rare decays

- The LNF node has performed an extensive analysis of rare K decays in the Minimal Supersymmetric extension of the Standard Model (MSSM), both within the restrictive MFV framework and within a more general framework with new sources of flavour-symmetry breaking, showing how rare K decays can restrict the parameter space of the model, even after taking into account the possible future information on the mass spectrum derived from high-energy colliders [4].
- Rare $B \to \tau\nu$ decay and the precise ΔM_{B_s} measurement, have been analysed by the INFN/LNF node together with other low-energy observables in the framework of the MSSM at large $\tan(\beta)$, including connections between rare B decays and the $(g-2)_\mu$ anomaly [5, 6].
- The members of the Orsay node at Ecole Polytechnique have studied the impact of the rare decay $B \to \pi\pi$ in the determination of the CKM angle α [7].

Quantum mechanics and the neutral meson system

- The Barcelona and INFN/Torino collaboration has shown that the neutral kaon systems are essentially the unique meson systems useful to perform Bell inequality tests. Definite proposals for these tests at Daphne II have been presented and other QM tests with neutral kaons have been proposed [8].
- The quantum eraser and marking concept can be tested with neutral kaons in a way not available in other quantum systems. A test of the kaonic quantum eraser at the upgraded KLOE 2 detector was suggested by a Barcelona-Torino-Vienna collaboration [9].

- New results were obtained by the Vienna group for the study of Bell inequalities for the entangled neutral kaon system that is fundamentally different from investigations using photons or other quantum systems [10].

To improve the theoretical precision for the CKM matrix elements

- A new estimate of the CKM element $|V_{us}|$ was obtained from hyperon semileptonic decays by the Valencia node [11].
- The INFN/Napoli group has played a major role in the complete compilation of all available data regarding kaon physics and related CP and CPT physics published by the Particle Data Group (PDG) [12]. This analysis has allowed a good determination of the Cabibbo angle which is one of the fundamental entries in the CKM matrix.
- An up-to-date profile of the CKM matrix with emphasis on the interpretation of recent CP violation results from B factories has been provided by the Marseille node [13], as well as a review of all the relevant theoretical and experimental inputs from the contributing domains of the weak interactions.
- The Orsay group has devised new precision tests involving semileptonic K decays of possible non standard couplings of right-handed quarks to W and of possible deviations from the unitarity of the effective CKM matrix [14].
- Concerning the exclusive determination of V_{cb}, the Orsay group has pursued the study of Bjorken-like sum rules extending it to subleading $1/m_Q$ form factors [15].
- The Durham node contributed to the determination of CKM angle γ, with the work of one of the node young researchers who collaborated to these studies within the BaBar collaboration.

1.1.2 Chiral Perturbation Theory

- The Bern group performed a detailed numerical study [16] of finite volume effects for masses and decay constants of the octet of pseudoscalar mesons. For this analysis, chiral perturbation theory and asymptotic formulae a la Luscher was used. An extension of the latter beyond the leading exponential term was proposed.

- An investigation of leading chiral logarithms in several QCD Green functions has revealed that these may be evaluated rather straightforwardly in the chiral limt, as was shown by the Bern group [17].

- The Bern node in a joint collaboration with the Helsinki node recalculated and confirmed the available two-loop expressions for the reaction $\gamma\gamma -> \pi\pi$ in the framework of chiral perturbation theory [18]. With updated values for the LECs at order p^4, the value of the dipole polarizability is in conflict with the experimental result recently reported by the MAMI Collaboration.

- Lund: ChPT for the case of partially quenched QCD relevant for lattice QCD has been fully extended to two-loop order and all the off-diagonal masses and decay-constants calculated[19]. The structure of the neutral two-point function has been investigated to all orders in this theory showing how to obtain the eta mass from partially quenched lattice simulations at NNLO in ChPT [20].

- Lund: A first calculation of finite volume effects in the three flavour case was done[21].

To determine effective low-energy couplings from first principles

- Within a joint project of Marseille, Valencia and Vienna, the most general chiral resonance Lagrangian was constructed that can generate chiral low-energy constants up to $O(p^6)$. By integrating out the resonance fields, the low-energy constants were parametrized in terms of resonance masses and couplings [22].
- The UAB node has found how the low-energy chiral expansion of certain observables at large N_c can be resummed at high (but finite) energies using the theory of Pade approximants to Stieltjes functions [23].
- The Orsay group has derived constraints on combinations of $\mathcal{O}(p^6)$ chiral coupling constants by matching a recent two-loop calculation of the pi-K scattering amplitude with a set of sum rules, focusing on flavour symmetry breaking terms related to vector resonances [24].
- The DESY Zeuthen-Marseille-Valencia collaboration has developed new QCD simulation algorithms, based on a method which allows simulations at fixed topological charge [25]. The new method is expected to allow to extract more reliably the low energy constants that determine the effectice chiral Lagrangian.

To investigate the order parameters of QCD

- A systematic method was derived by the Bern group [26] to determine the cusp structure of $K \to 3\pi$ decays. The framework allows one to include real and virtual photons in a systematic manner. It is expected that, using these amplitudes, the $\pi\pi$ scattering lengths $a_0 - a_2$ can be determined with high precision from NA48 data.

ChPT and kaon decays.

- The INFN/Napoli and UAB nodes have analyzed CP violation asymmetries in non-leptonic kaon decays which allow to uncover important tests of chiral dynamics and Standard Model (SM) and beyond SM tests and from the decays $K \to 3\pi$, $K \to \pi\pi\gamma$ due also to the recent data from NA48, uncovering, unambigously, the role of Vector meson dominance and determining the size of CP violation in the SM and beyond [27].

πK scattering

- In a joint project of Marseille and Vienna, the method of expansion by regions was applied to some two-loop integrals relevant for πK scattering at threshold. As an example, the leading strange quark contribution to the pion mass was evaluated [28].
- The UAB node has calculated the πK scattering lengths in fully-dynamical lattice QCD with domain-wall valence quarks on MILC lattices with rooted staggered sea-quarks. Accurate values for $a_{1/2}$ and $a_{3/2}$ have been obtained [29].
- The Orsay group has proved the existence of the light scalar meson $K_0^*(800)$ (also called κ) in a rigorous way [30]. Roy-Steiner representations of the $\pi K \to$

πK amplitude were exploited to determine from experimental data the analytic structure of the amplitude on the second Riemann sheet, and to find the κ pole with the following mass and width: $E_\kappa = 658 \pm 13$ MeV and $\Gamma_\kappa = 557 \pm 24$ MeV.

Resonance χPT

- The Valencia node has performed the one loop renormalization of the Resonance Chiral Theory Lagrangian including one multiplet of scalar and pseudoscalar resonances [31].

Baryon ChPT and Hypernuclei

- Meson-baryon scattering with $S = -1$ in S-wave [32, 33] was studied at Next-To-Leading order, in Unitary Chiral Perturbation Theory through a joint Valencia-UAB/Granada collaboration.
- The construction of the complete and minimal $\mathcal{O}(p^2)$ and $\mathcal{O}(p^3)$ baryon SU(3) Chiral Perturbation Theory Lagrangians was proposed in a joint Valencia-UAB/Granada collaboration [34].
- Important progress has been made by the joint Valencia-Barcelona collaboration in the field of kaon-nucleon interactions. [35, 36].
- The INFN/Torino-UAB collaboration has provided a clear evidence in favour of a solution of the long standing puzzle in the value of the ratio Γ_n/Γ_p in non-mesonic weak decay of Λ hypernuclei [37].

1.1.3 Quark masses

- The Valencia node, in a collaboration with INFN nodes, has studied the determination of non-perturbatively renormalized light quark masses within lattice simulations [38]
- Lund: the formulas needed for the partially quenched determination of meson masses and hence the quark mass have been extended to NNLO [39].
- The role of the charm quark mass in the $\Delta I = 1/2$ rule was studied by a joint Marseile-Valencia colaboration [40].
- The Karlsruhe team from DESY Zeuthen node has improved the determination of the strange quark mass by evaluating the scalar correlator in $\mathcal{O}(\alpha_s^4)$ and performing a reanalysis of scalar sum rules [41].

1.1.4 $\alpha_{em}(M_Z)$ and the anomalous magnetic moment of the leptons

$(g-2)_\mu$ and multi-loop calculations

- Marseille node: The integral representation of Feynman diagrams, in terms of the usual Feynman parameters, provide, when combined with properties of the Mellin-Barnes representation and the converse mapping theorem, a simple and efficient way to obtain the analytic asymptotic behaviours in expansions of both large and small ratios of masses. Applications to contributions occuring in $(g-2)_\mu$ have been worked out explicitly [42].

Precision determination of electroweak parameters

- Further progress was made by the DESY Zeuthen and Warsaw/Katowice nodes in calculating the full two-loop electroweak corrections to the effective leptonic weak mixing angle in the standard model. Final results were implemented in the ZFITTER program [43].
- Progress was made also in the calculation of contributions to the Bhabha process at two–loops by the DESY Zeuthen and Warsaw/Katowice nodes [44]. The complete two-loop virtual plus soft contributions were evaluated by the DESY Zeuthen/Karlsruhe node in [45, 46].

Hadronic Effects in electroweak precision observables

- By explicit calculation of the two–loop QCD corrections, the DESY Zeuthen node has shown that for singlet axial and vector currents the full off–shell $\langle VVA \rangle$ correlation function in the limit of massless fermions is proportional to the one–loop result. This extends the famous Adler-Bardeen non-renormalization theorem of the triangle anomaly to the non-anomalous transversal amplitudes at least up to two loops [47, 48].
- The Katowice/Warsaw node studied the role of the reaction $e^+e^- \to e^+e^-\pi^+\pi^-$ in the pion form factor measurements via radiative return method without photon tagging in detail in [49].
- The joint Valencia-DESY Zeuthen/Karlsruhe-Warsaw/Katowice collaboration continued development of PHOKHARA Monte Carlo event generator, which now includes three pions channel and kaon pair production, with an improved description of radiative corrections [50].
- The Katowice/Warsaw node presented reviews of the radiative return as a tool in hadronic physics in papers [51, 52, 53].
- The INFN/LNF node has considered the possibility to test Final State Radiation (FSR) models in the reaction $e^+e^- \to \pi^+\pi^-\gamma$ at DAFNE near $\pi^+\pi^-$ threshold, developing a Monte Carlo generator based on the Monte Carlo EVA, to study FSR in model-independent way based on experimental spectra [54].

1.1.5 Heavy flavour decays and Heavy Quark Effective Theory (HQET)

Heavy Quarkonia

- The UAB node has completed and published a comprehensive report on effective field theories for heavy quarkonia [55].
- In the Helsinki node the Hypercubic Blocking has been implemented and the corresponding energies and charge distributions of the heavy-light meson system have been measured in the lattice. Particular attention has been paid to extracting the P- and D-wave spin-orbit splittings [56].

τ decays

- The Valencia node studied both Scalar and Vector Form factors in $\tau \to K\pi\nu_\tau$ [57], in view of future B_τ decays measurements at the b-factories.

- The DESY Zeuthen/Karlsruhe has extended the MonteCarlo generator TAUOLA to include now also the decay mode $\tau \to \nu 5\pi$ [58].

D-decays

- The INFN/Bari group performed a phenomenological analysis of excited charmed meson decays aimed at constraining the effective Lagrangian describing their strong decays to light pseudoscalar mesons [59].
- The newly discovered charmed meson $D_{sJ}(2860)$ was studied by the INFN/Bari group [60].

B-decays

- A new method combining QCD factorisation and flavour symmetries to control $1/m_b$ infrared divergences has been proposed by the Barcelona and Orsay nodes jointly [61].
- The supersymmetric contributions to $B_s \to K^+K^-$ CP asymmetries and branching ratio have been studied by the Barcelona node [62].
- The Bern group performed [63] a calculation of the $O(\alpha_s^2)$ contribution to the decay width $\Gamma(\bar{B} \to X_s\gamma)$ which arises from the self-interference term of the electromagnetic dipole operator. This work is an important ingredient for the complete NNLL prediction of this decay width.
- Lund (Oslo): In a class of decays of the type $B \to \gamma D^*$ it was found that the nonfactorizable contributions clearly dominate [64].
- The Bern/Zurich and Warsaw nodes considered in [65] $\bar{B} \to X_s l^+ l^-$ decay rate known at the next-to-next-to-leading order in QCD and completed the calculation of logarithmically enhanced electromagnetic effects by including also QED corrections to the matrix elements of four-fermion operators.
- The photon spectra in radiative decays of various heavy quarkonium states provide important information on their nature and it was found by the UAB group that $\Upsilon(2S)$ and $\Upsilon(3S)$ are in the strong coupling regime. [66].
- INFN/Bari in collaboration with the group from Ecole Politechnique of the CNRS IN2P3 node studied the effects of Universal Extra Dimensions in rare B decays induced by $b \to s$ transition [67].
- The Bari group studied two body B_s decays exploiting $SU(3)_F$ symmetry and existing data on related B decays [68].

1.1.6 Strong Interaction limit of QCD

α_s in the infrared region

- In a joint INFN/LNF and Barcelona/Granada collaboration, further studies of the infrared limit of α_s have focused on the dependence of the total cross-section at LHC from the model used to simulate this limit [69] provinding predictions for LHC future measurements. The possibility of using a singular, but integrable, expression for α_s was shown to lead to a very good description of all proton data.

Meson and baryon Spectroscopy beyond the naive Quark Model

- A collaboration between the DESY-Zeuthen and Marseille nodes [70] has provided results for light meson and baryon masses, meson final state "wave functions," and other observables. An analysis of diquark correlations was also performed. The calculations were performed with Neuberger fermions on two sets of quenched Wilson gauge configurations at inverse lattice spacings of approximately 2.2 GeV and 1.5 GeV. The results indicate that scaling violations, if any, are small.
- It was shown in the Helsinki node that the recent experimental data on the strangeness form factors of the proton can be understood if the strange antiquark is in the ground state and the *uuds*-quark system has mixed spatial symmetry [71, 72], with one quark in the P-state.
- In the Helsinki node the Skyrme model for the baryons and light nuclei was further developed by an explicit canonical quantization of the SU(3) version of the model and by a canonical quantization of the Skyrme model for the alpha-particle [73] .

New mesons and baryons

- It was demonstrated [74] by the Bern group that near threshold, the $\pi\pi$ scattering amplitude contains a pole with the quantum numbers of the vacuum, commonly referred to as the sigma. Its mass and width was determined within small uncertainties. The derivation does not involve models or parametrizations, but relies on a straightforward calculation based on the Roy equation for the isoscalar S-wave.
- The LNF node participated to the preparation of the INFN Road map, which includes a comprehensive study of $\gamma\gamma$ physics at DAΦNE and its possibilities to measure the σ-meson structure [75].
- It was shown in the Helsinki node that the failure of the qqq constituent quark model in reproducing the empirical pion and electromagnetic decay widths of the lowest two nucleon resonances can be overcome, without breaking of SU(3) flavor symmetry, if the resonances contain modest admixtures of $qqqq\bar{q}$ components [76, 77].

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1.2 A.2 Joint Publications and Young Researcher Publications

In the following we list the joint publications by the network participants, in order of participant number. The list is ordered according to the node number of the first author, such that, if the first author belongs to node number 1, this publication will be first in the list. In the list of joint publications it is indicated which nodes and also (after the slash) which subnodes or external teams have participated. Throughout this report, references to the teams follow the description given in subsection 2.3 (**Work Plan**) in the included paragraphs dedicated to **Effort of the participants**.

We distinguish between papers published in refereed journals, conference proceedings and preprints.

1.2.1 Refereed Papers

1. G. Isidori, F. Mescia, P. Paradisi, C. Smith and S. Trine, *Exploring the flavour structure of the MSSM with rare K decays*, JHEP **08**, 064 (2006) [hep-ph/0604074]. **INFN/LNF-Bern-DESYZeuthen/Karslruhe**

2. F. Mescia, C. Smith and S. Trine, $K_L \to \pi^0 e^+ e^-$ *and* $K_L \to \pi^0 \mu^+ \mu^-$*: A binary star on the stage of flavor physics*, JHEP **08** (2006) 088 [hep-ph/0606081]. **INFN/LNF-Bern-DESYZeuthen/Karslruhe**

3. G. D'Ambrosio and D. Espriu, *Vector meson decays from the extended chiral quark model*, Phys. Lett. B **638** (2006) 487 [hep-ph/0602008]. **INFN/Napoli-UAB**

4. P. Colangelo, F. De Fazio, R. Ferrandes and T. N. Pham, *Exclusive* $B \to K^{(*)} \ell^+ \ell^-$, $B \to K^{(*)} \nu \bar{\nu}$ *and* $B \to K^* \gamma$ *transitions in a scenario with a single universal extra dimension*, Phys. Rev. D **73**, 115006 (2006) [hep-ph/0604029]. **INFN/Bari-CNRS IN2P3/Paris Ecole Polytechnique**

5. KLOE Collaboration *Measurement of the Absolute Branching Ratio for the* $K^+ \to \mu^+ \nu(\gamma)$ *Decay with the KLOE Detector*, Phys. Lett. **B 632** (2006) 76 [hep-ex/0509045]. **INFN/LNF-DESYZeuthen/Karslruhe**

6. KLOE Collaboration *Study of the decay* $\phi \to f_o(980)\gamma \to \pi^+ \pi^- \gamma$ *with the KLOE detector*, Phys. Lett. **B 634** (2006) 148 [hep-ex/0511031]. **INFN/LNF-DESYZeuthen/Karslruhe**

7. KLOE Collaboration *Precise measurement of* $\Gamma(K_S \to \pi^+ \pi^-(\gamma))/\Gamma(K_S \to \pi^o \pi^o)$ *with the KLOE detector at DA*Φ*NE*, submitted to Eur. Phys. J. **C** [hep-ex/0601025]. **INFN/LNF-DESYZeuthen/Karslruhe**

8. KLOE Collaboration *Study of the branching ratio and charge asymmetry for the decay* $K_S \to \pi e \nu$ *with the KLOE detector*, Phys. Lett. **B 636** (2006) 173 [hep-ex/0601026]. **INFN/LNF-DESYZeuthen/Karslruhe**

9. KLOE Collaboration *Measurement of the Form-Factor Slopes for the Decay* K_{Le3} *with the KLOE Detector*, Phys. Lett. **B 636** (2006) 166 [hep-ex/0601038]. **INFN/LNF-DESYZeuthen/Karslruhe**

10. KLOE Collaboration *Measurement of the Branching Ratio of the* $K_L \to \pi^+ \pi^-$ *decay with the KLOE Detector*, Phys. Lett. **B 638** (2006) 166 [hep-exp/0603041]. **INFN/LNF-DESYZeuthen/Karslruhe**

11. KLOE Collaboration *Measurement of the DAΦNE luminosity with the KLOE detector using large angle Bhabha scattering*, accepted by Eur. Phys. J. **C** [hep-ex/0604048]. **INFN/LNF-DESYZeuthen/Karslruhe**

12. KLOE Collaboration *Dalitz plot analysis of* $e^+e^- \to \pi^o\,\pi^0\gamma$ *events at* $\sqrt{s} \sim m_\phi$ *with the KLOE detector*, submitted to Eur. Phys. J. **C** [hep-ex/0609009]. **INFN/LNF-DESYZeuthen/Karslruhe**

13. F. Benatti, B.C. Hiesmayr and H. Narnhofer, *Multi-distributed entanglement in infinitely correlated chains (AKLT-model)*, Journal of Laser Physics **16**, 4 (2006). **INFN/Trieste-Vienna**

14. Jose A. Oller, Joaquim Prades and Michela Verbeni, *Reply to comment on 'Surprises in threshold antikaon-nucleon physics'*, Phys.Rev.Lett.96:199202,2006. [hep-ph/0601109]. **UVEG-UAB/Granada**

15. Jose A. Oller, Joaquim Prades and Michela Verbeni, *Surprises in threshold antikaon-nucleon physics* Phys.Rev.Lett.95:172502,2005. [hep-ph/0508081]. **UVEG-UAB/Granada**

16. E. Oset, D. Cabrera, V.K. Magas, L. Roca, S. Sarkar, M.J. Vicente Vacas and A. Ramos, *"Chiral dynamics of baryon resonances and hadrons in a nuclear medium*, Pramana **66** (2006) 731. **UVEG-UAB/Granada**

17. J. Hirn, N. Rius and V. Sanz, *"Geometric approach to condensates in holographic QCD*, Phys. Rev. **D73** (2006) 085005.**UVEG-UAB**

18. J. Hirn and J. Stern, *Lepton-number violation and right-handed neutrinos in Higgs-less effective theories*, Phys. Rev. **D73** (2006) 056001. **UVEG-CRNSIN2P3**

19. F. Jugeau, A. Le Yaouanc, L. Olive and J.-C. Raynal, *"The tensor force in heavy quark effective theory and the semileptonic* $\overline{B}$ *decay to excited vector mesons* $D((3/2)^-, 1^-)$, Phys. Rev. **D74** (2006) 017502. **UVEG-CRNSIN2P3**

20. F. Jugeau, A. Le Yaouanc, L. Oliver and J.-C. Raynal, *"Lagrangian perturbations at order* $1/m_Q$ *and the non-forward amplitude in heavy quark effective theory*, Phys. Rev. **D73** (2006) 074003. **UVEG-CRNSIN2P3**

21. D. Becirevic, B. Blossier, Ph. Boucaud, V. Giménez, V. Lubicz, F. Mescia, S. Simula and C. Tarantino, *"Non-perturbatively renormalized light quark masses from a lattice simulation with* $N_F = 2$, Nucl. Phys. **B734** (2006) 138. **UVEG-INFN/LNF**

22. M. Jamin, A. Pich and J. Portolés, *"Spectral distribution for the decay* $\tau \to K\pi\nu_\tau$, Phys. Lett. **B640** (2006) 176. **UAB-UVEG**

23. V. K. Magas, E. Oset, A. Ramos and H. Toki, *"A critical view on the deeply bound* K^-pp *system*, Phys. Rev. **C74** (2006) 025206. **UAB-UVEG**

24. L. Tolos, A. Ramos and E. Oset, *Chiral approach to antikaon s and p-wave interactions in dense nuclear matter*, Phys.Rev.C74:015203,2006. [nucl-th/0603033]. **UAB-UVEG**.

25. A. Bramon, R. Escribano, G. Garbarino, *Bell's inequality tests with meson-antimeson pairs*, Found.Phys.36:563-584,2006. **UAB-INFN/Torino**

26. R.M. Godbole, A. Grau, G. Pancheri and Y.N. Srivastava *Soft gluon radiation and energy dependence of total hadronic cross-sections*, Phys.Rev.D72:076001,2005. [hep-ph/0408355]. **UAB/Granada-INFN/LNF**

27. R.M. Godbole, A. Grau, R. Hedge, G. Pancheri, Y.N. Srivastava, *Theoretical expectations for total cross-sections at the large hadron collider*, Pramana **66** 657-668, 2006 [hep-ph/0604214]. **UAB/Granada-INFN/LNF**

28. R. Kaiser and J. Schweizer, *The expansion by regions in πK scattering*, JHEP **0606**, 009 (2006) [hep-ph/0603153]. **CNRS/CPT-Vienna**

29. V. Cirigliano, G. Ecker, M. Eidemüller, R. Kaiser, A. Pich and J. Portolés, *Towards a consistent estimate of the chiral low-energy constants*, Nucl. Phys. **B753**, 139 (2006) [hep-ph/0603205]. **CNRS CPT-UVEG-Vienna**

30. Sebastien Descotes-Genon, Joaquim Matias and Javier Virto, *Exploring B(d,s) —¿ KK decays through flavour symmetries and QCD-factorisation*, Phys.Rev.Lett.97:061801,2006. [hep-ph/0603239]. **CNRS IN2P3-UAB**

31. J. Bijnens, E. Gámiz and J. Prades, *The B_K Kaon Parameter in the Chiral Limit*, JHEP 03 (2006) 048 [hep-ph/0601197]. **Lund-UAB/Granada**

32. R. Babich, N. Garron, C. Hoelbling, J. Howard, L. Lellouch, C. Rebbi, *$K^0 - \bar{K}^0$ mixing beyond the standard model and CP-violating electroweak penguins in quenched QCD with exact chiral symmetry.* **DESYZeuthen-Marseille**

33. R. Babich, F. Berruto, N. Garron, C. Hoelbling, J. Howard, L. Lellouc *The B_K Kaon Parameter in the Chiral Limit*, JHEP 03 (2006) 048 [hep-ph/0601197]. **Lund-UAB/Granada**

34. F. Jegerlehner, K. Kołodziej and T. Westwanski, *One-loop electroweak factorizable corrections for the Higgsstrahlung at a linear collider*, Eur. Phys. J. C **44** , 195 (2005)[hep-ph/0503169]. **DESY Zeuthen-Warsaw/Katowice**

35. R. Babich, F. Berruto, N. Garron, C. Hoelbling, J. Howard, L. Lellouch, C. Rebbi, N. Shoresh, *Light hadron and diquark spectroscopy in quenched QCD with overlap quarks on a large lattice*, JHEP **0601**:086,2006 [hep-lat/0509027]. **DESY Zeuthen-Marseille**

36. J. Gasser, M.A. Ivanov and M.E. Sainio, *Low-energy photon-photon collisions to two loops revisited*, Nucl. Phys. **B728** (2005) 31 [hep-ph/0506265]. **Bern-Helsinki**

37. J. Gasser, M.A. Ivanov and M.E. Sainio, *Revisiting $\gamma\gamma \to \pi^+\pi^-$ at low energies*, Nucl. Phys. **B745** (2006) 84 [hep-ph/0602234]. **Bern-Helsinki**

38. T. Huber, E. Lunghi, M. Misiak and D. Wyler, *Electromagnetic logarithms in anti-B –¿ X/s l+ l-* Nucl. Phys. B **740**, 105 (2006) [arXiv:hep-ph/0512066] **Bern/Zurich-Warsaw**

39. H. Czyz, A. Grzelinska, J. H. Kuhn and G. Rodrigo *Electron positron annihilation into three pions and the radiative return* Eur. Phys. J. C **47**, 617 (2006) [arXiv:hep-ph/0512180] **Warsaw/Katowice-DESY Zeuthen/Karlsruhe-Valencia**

40. M. Gorbahn, U. Haisch and M. Misiak, *Three-loop mixing of dipole operators*, Phys. Rev. Lett. **95** (2005) 102004 [hep-ph/0504194]. **Durham-Warsaw**

1.2.2 Conference Proceedings

1. G. Pancheri, R.M. Godbole, A. Grau and Y.N. Srivastava, *Total cross sections and soft gluon resummation*, presented at PLC2005 Kazimierz, Poland, 3-8 Sep 2005. Acta Phys. Polon.B37:1093-1102, 2006 [hep-ph/0604211]. **INFN/LNF-UAB/Granada**

2. G. Pancheri, R.M. Godbole, A. Grau and Y.N. Srivastava, *Aspects of confinement in total cross sections through Bloch-Nordsieck soft gluon summation*, Nucl. Phys. Proc. Suppl.146:177-181,2005. **INFN/LNF-UAB/Granada**.

3. A. Bramon, G. Garbarino and B.C. Hiesmayr, *Kaonic Quantum Erasers at KLOE 2: Erasing the Present, changing the Past*, to be published in Frascati Physics Series, invited talk. **INFN/Torino-UAB-Vienna**

4. D. Leone for the KLOE collaboration *Measurement of the hadronic cross section* $\sigma(e^+e^- \to \pi^+\pi^-\gamma)$ *with KLOE*, Int. Workshop on Tau Lepton Physics Tau04, Sept. 14-17, 2004, Nara (Japan) Nucl. Phys. (Proc. Suppl.) **B 144** (2005) 231. **INFN/LNF-DESYZeuthen/Karslruhe**

5. A. Denig for the KLOE Collaboration *Measuring the Hadronic Cross Section via Radiative Return at DAΦNE*, 10^{th} Int. Symposium on Meson-Nucleon Physics and the Structure of the Nucleon, August 29-Sept. 4, 2004, MENU 2004, Beijing, Int. J. Mod. Phys. **A 20** (2005) 1935. **INFN/LNF-DESYZeuthen/Karslruhe**

6. S. E. Müller for the KLOE Collaboration *KLOE results at the Frascati ϕ-factory DAΦNE*, 10^{th} Int. Symposium on Meson-Nucleon Physics and the Structure of the Nucleon, August 29-Sept. 4, 2004, MENU 2004, Beijing, Int. J. Mod. Phys. **A 20** (2005) 1888 [hep-ex/0411081]. **INFN/LNF-DESYZeuthen/Karslruhe**

7. F. Jugeau, A. Le Yaouanc, L. Oliver and J.-C. Raynal, *"Sum rules for leading and subleading form-factors in heavy quark effective theory using the non-forward amplitude*, AIP Conf. Proc. **806** (2006) 173. **UVEG-CNRS IN2P3**

8. E. Oset, V.K. Magas and A. Ramos, *Evidence for two Lambda(1405) resonance states*, AIP Conf.Proc.814:273-277,2006. [nucl-th/0512090]. **UVEG-UAB**.

9. Elvira Gamiz, Joaquim Prades and Ignazio Scimemi, $K \to 3\pi$ *final state interactions at NLO in CHPT and Cabibbo's proposal to measure a0 - a(2)*, [hep-ph/0602023] CAFPE-53-05 (Feb 2006) 28p. **UAB/Granada-UVEG**

10. Joaquim Prades, Elvira Gamiz and Ignazio Scimemi, *Charged kaon* $K^+ \to 3\pi$ *CP violating asymmetries vs epsilon'(K) / epsilon(K)*, [hep-ph/0509346] CAFPE-64-05 (Sep 2005) 8p. **UAB/Granada-UVEG**

11. R. Babich, F. Berruto, N. Garron, C. Hoelbling, J. Howard, L. Lellouch, C. Rebbi, N. Shoresh, *Light hadron spectroscopy in quenched QCD with overlap fermions*, 23rd International Symposium on Lattice Field Field: Lattice 2005, Trinity College, Dublin, Ireland, 25-30 Jul 2005. **PoS LAT2005**:043,2006 [hep-lat/0509182]. **DESYZeuthen-Marseille**

12. J.-M. Gérard, C. Smith and S. Trine, *Tracking down penguins at the poles*, Talk given at 41st Rencontres de Moriond on Electroweak Interactions and Unified Theories, La Thuile, Aosta Valley, Italy, 11-18 Mar 2006, hep-ph/0605165. **Bern-DESY Zeuthen/Karlsruhe**

13. S. Wycech and A.M. Green, *K-matrix analysis of ^{3}He-η system and $\eta - \pi^0$ mixing*, Int. J. Mod. Phys. **A20** (2005) 637-639. **Warsaw-Helsinki**

14. S. Wycech, A.M. Green, *K fragments* Proc. Int. Conf. on Exotic Atoms and Related Topics, EXA05, Austrian Academy of Science Press, Vienna 2005, p 101. **Warsaw-Helsinki**

1.2.3 Preprints

1. E. Bauer, G. Garbarino, A. Parreño and A. Ramos, *Single and double coincidence nucleon spectra in the weak decay of Λ hypernuclei*, Submitted to Phys. Rev. C [nucl-th/0602066]. **INFN/Torino-UAB**

2. J. A. Oller, M. Verbeni and J. Prades, *"Meson-baryon effective chiral Lagrangians to $\mathcal{O}(p^3)$*, [hep-ph/0608204]. To be published in JHEP. **UVEG-UAB/Granada**

3. J. Hirn and V. Sanz, *"A negative S parameter from holographic Technicolor*, [hep-ph/0606086. **UVEG-UAB**

4. Jose Antonio Oller, Michela Verbeni and Joaquim Prades, *Meson-Baryon Effective Chiral Lagrangians to $\emptyset(q^3)$*, [hep-ph/0608204] (Aug 2006) 19p. **UVEG-UAB**

5. E. Oset, A. Ramos, et al., *Recent developments in chiral dynamics of hadrons and hadrons in a nuclear medium*, [nucl-th/0607051] FTUV-06-0724 (Jul 2006) 8p. **UVEG-UAB**.

6. E. Oset, V.K. Magas and A. Ramos, *On the nature of the Lambda(1405) as a superposition of two states*, [hep-ph/0512361] FTUV-05-1229 (Dec 2005) 5p. **UVEG-UAB**

7. F. Jugeau, A. Le Yaouanc, L. Oliver and J.-C. Raynal, *"Form of Isgur-Wise function in the BPS limit*, [hep-ph/0604059]. **UVEG-CNRS IN2P3**

8. E. Gámiz, J. Prades and I. Scimemi, *"$K \to \pi\pi\pi$ final state interactions at NLO in Chiral Perturbation Theory and Cabibbo's proposal to measure $a_0 - a_2$*, [hep-ph/0602023]. **UAB/Granada-UVEG**

9. M. Jamin, J.A. Oller and A. Pich, *"Scalar $K\pi$ form factor and light quark masses*, [hep-ph/0605095]. **UAB-UVEG**

10. C. Buttar et al., *Les houches physics at TeV colliders 2005, standard model and Higgs working group: Summary report.* Contributed to Les Houches Workshop on Physics at TeV Colliders, Les Houches, France, 2-20 May 2005 [hep-ph/0604120]. **UAB/Granada-INFN/LNF**

11. R. Babich, N. Garron, C. Hoelbling, J. Howard, L. Lellouch and C. Rebbi, *K0 anti-K0 mixing beyond the standard model and CP-violating electroweak penguins in quenched QCD with exact chiral symmetry*, hep-lat/0605016. **DESYZeuthen/Karslruhe-Marseille**

1.2.4 Young Researcher Publications for the entire period

In the following we list publications by the all young researchers financed by the contract during the **entire** contract period , ordered according to the node where they were appointed. For each young researcher, we include all the publications during their network appointment.

Rene Unterdorfer : INFN-LNF

- G. Isidori, C. Smith, R. Unterdorfer, *The Rare Decay $K_L \to \pi^0\mu^+\mu^-$ within the SM*, Eur.Phys.J.C36:57-66,2004 [hep-ph/0404127].
- G. Isidori, R. Unterdorfer, *On the Short Distance Constraints from $K_{L,S} \to \mu^+\mu^-$*, JHEP 0401:009,2004 [hep-ph/0311084].

Christopher Smith : INFN-LNF

- G. Isidori, C. Smith, R. Unterdorfer, *The Rare Decay $K_L \to \pi^0\mu^+\mu^-$ within the SM*, Eur.Phys.J.C36:57-66,2004 [hep-ph/0404127].
- Christopher Smith ,*'Recent progress on the rare decay $K_L \to \pi^0\mu^+\mu^-$*, Short talk given at DAFNE 2004: Workshop on Physics at Meson Factories, Rome, Frascati, Italy, 7-11 Jun 2004 [hep-ph/0407361].
- G. Isidori, F. Mescia and C. Smith, *Light quark loops in $K \to \pi\nu\bar{\nu}$*, Nucl. Phys. **B718** (2005) 319-338 [hep-ph/0503107].
- C. Smith, *Long Distance Effects in rare K-decays*, Talk given at the 40th Rencontres de Moriond on Electroweak Interactions and Unified Theories, La Thuile, Aosta Valley, Italy, 5-12 March 2005 [hep-ph/0505163].
- J.-M. Gérard, C. Smith and S. Trine, *Radiative Kaon Decays and the Penguin Contribution to the $\Delta I = 1/2$ Rule*, Nucl. Phys. **B 730** 1-36 2005 [hep-ph/0508189].

Stéphanie Trine : INFN-LNF

- S. Trine, *Strong and electromagnetic anomalies in weak meson decays*, UCL thesis catalogue Dec 2004.
- J.-M. Gérard, C. Smith and S. Trine, *Radiative Kaon Decays and the Penguin Contribution to the $\Delta I = 1/2$ Rule*, Nucl. Phys. **B 730** 1-36 2005 [hep-ph/0508189].

Johannes Hirn : University of Valencia

- J. Hirn and J. Stern, *Lepton-number violation and right-handed neutrinos in Higgs-less effective theories* [hep-ph/0504277].
- J. Hirn and J. Stern, *Higgs-less Higgs mechanism: low-energy expansion*, to appear in the proceedings of the 40th Rencontres de Moriond on Electroweak Interactions and Unified Theories, La Thuile, Aosta Valley, Italy, 5-12 March 2005 [hep-ph/0507222].
- J. Hirn and V. Sanz, *Interpolating between low and high energy QCD via a 5-D Yang-Mills Model* [hep-ph/0507049].
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2 B - COMPARISON WITH THE PROJECT PROGRAM

2.1 B1. Research Objectives

All the research objectives described in the Contract and reproduced in the previous section, have been achieved. In the subsection dedicated to the work plan, more details about the progress and final completion of the project, can be found.

2.2 B.2 Methodological Approach and Work Plan

There has been no change in the research method described in our Contract, which was based on the use of *Effective Theories of Colours and Flavours* applied to the study of elementary particle interactions through data collected by experiments in the low and intermediate energy region, like KLOE and DEAR at DAPHNE, WASA, NA48, DIRAC, BaBar, BELLE, CESR-C, FOCUS, SELEX, B-TeV, HERA-B, LHC-B. The theoretical methods used have included

- Chiral Perturbation Theory
- Large N_c- expansion
- QCD Lattice simulations
- Heavy Quark Effective Theory
- Exact Renormalization Group
- QED and Perturbative QCD
- Quantum Mechanics

2.3 B.3 Work Plan

Breakdown of Tasks

The work plan of the EURIDICE network was structured in a number of tasks, grouped into three main groups. This structure is reproduced in the three tables which follow, where we have , we have included

a $\star$ to indicate the assigned tasks at the time of the Contract

a $\surd$ to indicate the involvement of the groups during the first year of operation (see First Periodic Report),

a $\bullet$ for the involvement at the time of the Midterm Report

an $\oplus$ for involvement at the time of the fourth periodic report, namely at the end of the contract.

Notice that, with respect to the contract, the last two columns in Table 2 have been relabelled so as to include a number of items related to the given task. Thus, the column α_s *in the infrared* includes now also *Structure functions* and *total cross-sections*, whereas *glueballs spectroscopy* includes the study of scalar mesons and the newly observed exotic

quarkonia. From these tables one can see that all the tasks have been addressed by the nodes. This has happened sometimes as originally planned, sometimes through the work of nodes not originally involved in that particular task. This follows the natural evolution of fundamental research and theoretical physics in particular, where researchers may start new research avenues, not originally planned.

Table 1: Task Assignments in theoretical developments in Effective Field Theories

Team	Quark masses	ChPT 3 flav ours	Isospin breaking effects	Large N_c QCD	N_f/N_c dependence	Lattice QCD and and ChPT	HQET and LEET	EFT in Nuclear matter
INFN		$\oplus$	$\star$	$\oplus$		$\oplus$	$\star\surd\bullet\oplus$	$\star\bullet\oplus$
UVEG	$\star\surd\bullet\oplus$	$\star\oplus$	$\star\surd\bullet$	$\star\surd\bullet\oplus$		$\star\bullet$	$\star\oplus$	$\star\surd$
UAB	$\surd\bullet$	$\star\surd\bullet\oplus$		$\star\surd\bullet\oplus$	$\star\bullet$			
CNRS CPT		$\star$	$\star\oplus$	$\star\bullet\oplus$		$\star\surd\bullet\oplus$	$\star\oplus$	
CNRS-IN2P3	$\star\bullet$	$\star\surd\bullet\oplus$	$\star\bullet\oplus$	$\star\oplus$	$\star\surd$		$\star\surd\bullet\oplus$	
DUR	$\bullet\oplus\star$		$\star$			$\oplus$		$\star\oplus$
ULUND	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\bullet\oplus$	$\star\surd\bullet\oplus$		$\star\surd\bullet\oplus$	$\surd\bullet\oplus$	
UHELS	$\star\bullet$	$\star\bullet\oplus$	$\star\bullet\oplus$	$\surd\bullet\oplus$		$\surd$		
DESY Zeuthen	$\star\bullet\oplus$		$\star\bullet\oplus$			$\star\surd\bullet\oplus$		
UNIBE	$\star\bullet$	$\star\surd\bullet\oplus$	$\star\surd\bullet$	$\star$		$\surd\bullet\oplus$	$\star\bullet\oplus$	
Vienna	$\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\surd\bullet\oplus$				
Warsaw		$\star$	$\star\oplus$					

Table 2: Task Assignments in theoretical estimates and modelling of precision measurements

Team	CP CPT QM	CKM Matrix	Rare K-decays	Charm and Beauty decays	$(g-2)_\mu$ and α_{QED}	α_s in infrared structure functions σ_{total}	glueballs scalars exotics and spectro scopy
INFN	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\bullet$	$\star\surd\bullet\oplus$	$\bullet$
UVEG	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star$	$\star\surd\oplus$	$\star\surd$		$\bullet\oplus$
UAB	$\star\surd\bullet$	$\star\bullet\ \surd$	$\star\oplus$	$\star\surd\bullet$	$\surd\bullet$	$\surd\oplus$	$\bullet$
CNRS CPT	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd$	$\star\surd\bullet\oplus$		$\bullet$
CNRS-IN2P3	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\oplus$	$\star\surd\bullet\oplus$			
DUR				$\star\surd\bullet\oplus$	$\star\ \oplus$	$\star\bullet\oplus$	$\star\surd\bullet\oplus$
ULUND	$\star\surd\bullet\oplus$	$\star\surd$	$\star\oplus$	$\star\surd\bullet\oplus$			
UHELS				$\star\surd\bullet\oplus$			$\star\surd\bullet\oplus$
DESY Zeuthen	$\oplus$				$\star\surd\bullet\oplus$		
UNIBE	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\oplus$	
Vienna	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\bullet$		$\star$		
Warsaw	$\star\surd$	$\surd$	$\star$	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\bullet\oplus$	$\star\oplus$

Table 3: Task Assignments in studies for future or upcoming experiments

Team	Hadronic atoms at DEAR and DIRAC	η,η' at WASA and KLOE	MC and Rad.Corr. for σ_{had} at KLOE and PEPII	τ-Charm factories	Kaon-Nucleon scattering	Hyper nuclei from FINUDA
INFN	$\star\oplus$	$\bullet\oplus$	$\star\bullet\oplus$		$\star\oplus$	$\star\bullet\oplus$
UVEG			$\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$	$\star\surd\oplus$
UAB		$\star\oplus$		$\star\surd\bullet\oplus$	$\star\bullet\oplus$	$\star\surd\bullet$
CNRS CPT	$\star$	$\star$		$\star$		
CNRS-IN2P3	$\star\oplus$	$\star$		$\star\oplus$		
DUR				$\star\surd\bullet\oplus$	$\star\bullet\oplus$	$\star\surd\bullet\oplus$
ULUND	$\surd$	$\star\surd\oplus$				
UHELS	$\star\surd\bullet\oplus$	$\star\surd\bullet\oplus$		$\star\bullet\oplus$		
DESY Zeuthen			$\star\surd\oplus$			
UNIBE	$\star\surd\bullet\oplus$	$\star$			$\star\bullet$	
Vienna				$\star$		
Warsaw	$\star\bullet\oplus$	$\star\oplus$	$\star\surd\bullet\oplus$	$\star\oplus$	$\star\bullet\oplus$	$\oplus$

Research Effort of the participants

This network consists of 1 Coordinator and 11 participants, 10 of which from Member States and 1 from Switzerland. Some of the teams include researchers belonging to different institutions, as we specify in the following.

1. Istituto Nazionale di Fisica Nucleare [INFN-LNF] established in Italy which includes external team members from Sezione INFN di Roma1, Sezione INFN di Roma3, Sezione INFN di Napoli, Sezione INFN di Bari, Sezione INFN di Perugia, Sezione INFN di Bologna, Sezione INFN di Trieste, Sezione INFN di Torino

2. University of Valencia [UVEG] established in Spain which includes external team members from University of Madrid

3. Universitat Autonoma de Barcelona [UAB] established in Spain which includes external team members from Universidad de Granada, Universitat de Barcelona, Universitat Politecnica de Catalunya

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, which includes external team members from IPN- Orsay, LPT - Orsay, Ecole Polytechnique - Palaiseau, LPNHE - Paris.

6. Universiy of Durham [DUR] established in the United Kingdom which includes external team members from Oxford University, University of Manchester

7. University of Lund [ULUND] established in Sweden which includes external team members from University of Oslo, Norway

8. University of Helsinki [UHELS] established in Finland

9. DESY Zeuthen [DESY Zeuthen] established in Germany which includes external team members from University of Karslruhe

10. University of Bern [UNIBE] established in Switzerland which includes external team members from University of Zurich

11. Universitat Wien [UWIEN.ITP] established in Austria

12. Warsaw University [Warsaw] established in Poland which includes external team members from IPJ (Soltan Institute of Nuclear Studies), Warsaw and University of Silesia, Katowice

The network has two subnodes

- University of Oslo, Norway, as a subcontractor of University of Lund, Sweden
- University of Karslruhe, Germany, as a subcontractor of DESY Zeuthen, Germany

Table 4 illustrates the involvement of scientists from different nodes in comparison with what was stated in Annex I of the Contract. As one can see, the original involvement is very similar to the final count. The main disagreement concerns the Bern node, with 226

Table 4: EURIDICE Research Effort after 3 years of operation: Columns (c) and (d) include also the young researchers financed by the Contract

Professional research effort on the network project							
$N.^o$	Team	Young Researchers to be financed by the contract (person-months) (a) as in the contract, (b) as of 31/08/06		Total Researchers financed from all sources (person-months)/year (c) as in the contract, (d) as of 31/08/06		Researchers contributing to the project (number of individuals) (e) as in the contract, (f) as of 31/08/06	
		(a)	(b)	(c)	(d)	(e)	(f)
1.	INFN	48	51	155	188	30	29
2.	UVEG	30	40.5	200	209	19	21
3.	UAB	30	32	222	240	26	28
4.	CNRS DR12	24	24	80	62	12	9
5.	CNRS-IN2P3	24	23	66	77	12	12
6.	DUR	48	49	60	87	10	12
7.	ULUND	13	24	53	47	6	6
8.	UHELS	13	13	58	42	8	7
9.	DESY Zeuthen	24	24	122	103	13	20
10.	UNIBE	24	23	226	132	13	13
11.	Vienna	24	26	60	65	9	8
12.	Warsaw	0		67	50	11	8
Totals		302	329.5	1369	1302	169	173

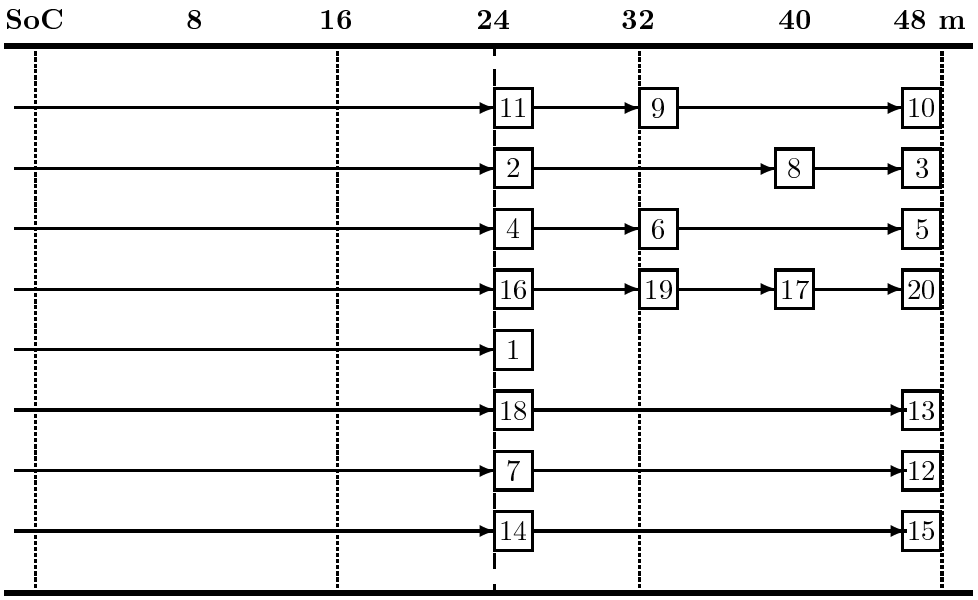
pm/year vs. actual 132 pm/year in colums (c) and (d). Notice that the involvement by the Bern node as stated in the contract contained a factual mistake, since it is impossible to have 226 months/year with 13 researchers. The actual numbers are as stated in the Table. If one takes into account this factual mistake, then the originally promised involvement becomes 1265 person-month/year and one can see that the actual involvement at the end of the contract has surpassed what had been promised both as number of training person-months, as well as in person-months and number of researchers working on the contract.

Schedules and Milestones

The Euridice Collaboration project has been a joint effort between experimentalists and theorists, aimed to extract informations in the low energy regime explored by the accelerator DAΦNE. As such, some of our milestones have been necessarily connected to the progress of the experimental program and may have been sometimes out of step with the original milestones. However, at the end of the fourth year one can say that all the milestones have been reached.

To illustrate this, we reproduce the milestone table in our contract. At the right of this table, the objectives of the project are reproduced, while the numbers in the table refer to the specific tasks related to each objective. Status of accomplishment of the milestones is discussed in conjunction with the table in the next page.

EURIDICE Schedule and Milestones



Project Objectives
CP & CKM
ChPT-I
ChPT-II
ChPT-III
Quark masses
$\alpha_{em}(M_Z)$ **&** $(g-2)_\mu$
Heavy flav. & HQET
Strong QCD

Legend: SoC=Start of Contract, m=months

Here we list the tasks using different markings to indicate whether a given milestone has been reached and if it has stimulated further work. As a final comment, concerning the milestone table, we point out that a theoretical project in fundamental physics is really never completed. There are always new features that appear when a given part of the puzzle has been solved. This is why we distinguish between tasks which have been *completed* and tasks whose initial plan has been completed but where work was stimulated by the opportunities offered by the network contract, and in whose direction *new and promising* research activities still take place.

Tasks:

1 Quark masses $\odot$
2 ChPT with 3 flavours $\star$
3 Isospin breaking effects $\star$
4 Large-N_c QCD $\odot$
5 N_f/N_c dependence $\star$
6 Lattice QCD and ChPT $\odot$
7 HQET and LEET $\star$
8 EFT in nuclear matter $\odot$
9 CP, CPT and QM $\odot$
10 CKM matrix $\odot$
11 Rare K-decays $\star$
12 Charm and Beauty decays $\odot$
13 $(g-2)_\mu$ and $\alpha_{\rm QED}$ $\star$
14 α_s in the infrared region and structure functions $\odot$
15 Glueballs, scalars, exotics and spectroscopy $\star$
16 Hadronic atoms at DEAR and DIRAC $\star$
17 η and η' at WASA and KLOE $\star$
18 Monte-Carlo methods and radiative corrections for $\sigma_{\rm had}$ at KLOE and PEPII $\star$
19 Kaon-Nucleon scattering $\odot$
20 Hypernuclei at FINUDA $\odot$

$\star$ completed,

$\odot$ initial plan completed, new developments have appeared.

2.4 B.4 Organization and Management

2.4.1 B.4.1 Coordination and communication strategy

- *Network organization and management :* The network is organized following the guidelines described in the Work Program. Coordination and communications were based on the Team Committee constituted by the 12 scientists in charge, who exchanged frequent e-mails and telephone calls to discuss and plan both network meetings as well as the training programme. The state of the network could be regularly checked through the network web page,

  http://www.lnf.infn.it/theory/rtn/

  where announcement of meetings as well as available positions were posted.

- *Decision making :* The process followed along the work program, through operation of the Network Executive Committee, consisting of the 12 scientists in charge, implemented by representatives from the two subnodes, i.e. Karlsruhe (DESY-Zeuthen subnode) and Oslo (Lund subnode), by the representative from the Granada team, by the monitor of progress in B-physics, L. Oliver fom the Orsay node, and the Analysis Coordinator of the KLOE experiment, J. Lee-Franzini from the LNF-INFN node. During the fourth year of operation, one meeting of the Executive Committee was held :

  EXECUTIVE COMMITTEE

  February 8th, 2006 in Marseille to plan for the Final Collaboration Meeting and Final report.

- *Publications and dissemination of information :* The network results have been published in journals, and/or electronic bulletin boards, and/or presented at Conferences. The publication record of the network can be found from the network webpage, where the publications from each node have a dedicated space. In this space, accessing SPIRES, the link http://www.lnf.infn.it/theory/rtn/papers.htm listed in real time the publications by each member of each node of the network.

- *Presentation at International Conferences :* During the reporting period, network members have participated with presentations and invited talks to many International Conferences, Worshops and Schools. Various members were convenors of dedicated session.

  In the following, for brevity, we list only the main International Conferences where members of the network gave plenary or invited talks :

  ⋆ The Photon: its First Hundred Years and the Future, Warsaw Poland, 28 August-3rd September 2005

  ⋆ ETA'05 Conference, Krakow, Poland, 15-18/9/2005

  ⋆ DESY Theory Workshop, Hamburg, Germany 27-30/9/2005

  ⋆ Flavour Physics in the LHC era, CERN, 7-10 Nov 2005

  ⋆ ChPT confronts lattice QCD, Valencia, Spain,29-30/11/2005

  ⋆ Hadron Physics Symposium GSI Darmstadt, Jan. 21, 2006

⋆ Int. Workshop e^+e^- collisions from ϕ to ψ, Budker Institute of Nuclear Physics, Siberian Branch of Russian Academy of Science, Novosibirsk, Russia, Feb. 27-March 2, 2006

⋆ Rencontres de Moriond, 18 - 25 March 2006, QCD and high energy hadronic interactions, La Thuile, Aosta, Italy.

⋆ Flavour Physics and CP violation (FPCP06), Vancouver, 7 - 12 April 2006

⋆ Continuous Advances in QCD 2006, May 11-14 2006, Minneapolis (Minnesota)

⋆ First Workshop on Theory, Phenomenology and Experiments in Heavy Flavour Physics, Anacapri, Italy, May 29-31, 2006

⋆ International Workshop on Precision Physics of Simple Atomic Systems (PSAS 2006), Venice Italy, June 12-16, 2006

⋆ Charm2006, Beijing (June 2006)

⋆ Int. Workshop on Exotic Atoms, ECT* Trento, 19 - 24 Jun 2006

⋆ Meson 2006, June 2006, Krakow, Poland.

⋆ Zuoz Summer School on Particle Physics, Zuoz, July 16-22, 2006

⋆ International Conference on High Energy Physics, Moscow, 26th July, 2006.

⋆ Soft-Pions in Hard Processes, Regensburg, Germany, 2-6/8/2006

2.4.2 B.4.2 Network meetings

As part of the training and networking program, three types of meetings were organized during the fourth year of operation, namely

⋆ General meetings,

⋆ Topical workshops

⋆ LNF Spring School.

For all these meetings, we reproduce the poster, the list of participants and the scientific program at the end of this report. The list of such meetings follows :

- **Meeting** on e+e- physics perspectives (non-K decays) at Frascati e+e- collider, Frascati, 19-20th January 2006.

  Organized by the INFN/LNF node and attended by 50 physicists including members of the network.

- Workshop on **Chiral Perturbation Theory confronts Lattice QCD**, Valencia (Spain), 29th-30th November (2005).

  Organized by P. Hernandez and A. Pich and attended by 44 participants.

- **IV Collaboration Meeting** Marseille, 8-11th February 2006.

  Organized by Marc Knecht, attended by 50 participants from the network.

- LNF Spring **School** Bruno Touschek, Frascati, May 15-19th 2006.

  Organized by G. Pancheri, attended by approximately 50 students, including young researchers of the network, and PhD students from Italian and European Universities from the network.

- **Final Collaboration Meeting**, Kazimierz, Poland, 24-27th August 2006.

  Organized by Maria Krawczyk and Henryk Czyz from the Warsaw/Katowice node and Giulia Pancheri, and attended by 48 physicist, with external participants as well.

2.4.3 B.4.3 Networking

As one can see from the list of joint publications, a large number of scientific exchanges took place among network participants during the fourth year of operation, continuing and expanding the collaboration among nodes. In particular the following visits and secondments tool place between nodes :

1. R. Escribano and A. Bramon from UAB node came to Frascati in January 2006 to partecipate to discussions and *Workshop on Future LNF Programs*
2. A. Grau from UAB/Granada came to Frascati in july 2006 to work on total cross-sections with G. Pancheri
3. J. Oller (Valencia node) visited U. de Granada, 23rd-30th October 2006.
4. M. Verbeni (Valencia node) visites U. de Granada one week per month since Jan. 2006.
5. M. Sainio from Helsinki visited Bern to work on pion polarizabilities in December 2005.
6. A.M. Green from Helsinki visited Warsaw in May 2006 for one month to work with S. Wycech.
7. F. De Fazio (INFN/Bari) visited Vienna in Jan. 2006 for a seminar and for discussions on Soft Collinear Effective Theories.
8. J. Gasser (Bern) visited Vienna in March 2006 for a seminar and for discussions on various topics in chiral perturbation theory.
9. R. Kaiser (CNRS CPT Marseille) and J. Portolés (Valencia) visited Vienna in June 2006 to work with G. Ecker on the determination of low-energy constants.
10. J. Portolés (UVEG) visited the Marseille node (1st-6th May 2006).
11. J. Portolés (UVEG) visited the Vienna node (18-25th June 2006).
12. G. Rodrigo (UVEG) visited the Karlsruhe subnode (21st-27th July 2006).
13. J.A. Oller (UVEG) visited the Granada subnode (26-29th June 2006).
14. J. Hirn has (UVEG) visited the Granada subnode for a full period of 6 weeks along the months of November (2005), February (2006) and April (2006).
15. J. Hirn (UVEG) has visited the Orsay node for one week in November (2005) and one week in February (2006).
16. F. Jugeau (UVEG) has visited the Orsay node for one week in January (2005).

17. F. Jugeau (UVEG) has visited the Bari subnode for one week in February (2006) and one week in April (2006).

18. F. Jegerlehner (DESY Zeuthen) visited Frascati (23th November - 13th December 2005)

19. F. Jegerlehner (DESY Zeuthen) visited Frascati (22th Mai - 4th June 2006)

20. H. Czyz (Warsaw/Katowice) visited Karlsruhe (DESY Zeuthen) 2 months (oct-dec) in 2005) and again 1 month (Jan-February) in 2006

21. H. Czyz (Warsaw/Katowice) visited for 2 weeks INFN/LNF (Frascati) node in September-October 2005

22. E. Nowak-Kubat (Warsaw/Katowice) for two weeks INFN/LNF (Frascati) in September-October 2005

23. E. Nowak-Kubat (Warsaw/katowice) visited for 2 weeks the DESY Zeuthen/Karlsruhe node in November 2005

24. E. Nowak-Kubat and H. Czyz (Wasaw/Katowice) visited INFN Bologna (two weeks each)

25. K. Kołodziej (Warsaw/Kaeowice) spent 2 times two weeks at DESY-Zeuthen in 2005

26. S. Wycech (Warsaw) visited Helsinki for one month in November 2005

27. M. Misiak (Warsaw) visited INFN-Torino for one week in February 2006

2.5 B.5 Training

2.5.1 B.5.1 Measures taken to publicize vacant positions

Vacant positions were advertized through the Cordis page, through the network page, through electronic distribution of the advertisement to the CERN theoretical group mailing list and to individual node e-mail lists. All the available positions had been advertized and filled.

2.5.2 B.5.2 Progress in recruitment of young reseachers

The training plan has been completed and even surpassed. In the accompanying Table 5, we show the original training plan together with the training delivered at the end of the fourth year, where *pm* indicates the length of the contract in person-months.

We notice a few changes wrt the contract or previously expected hiring periods:

1. The INFN node has increased its deliverable from 48 months to 51 months of training, through shift of 1 month of training funds from Orsay node, CNRS/IN2P3 to INFN/LNF. With these funds, the INFN/LNF node has extended the training period of the young researcher Stephanie Trine by three months, until the end of December 2005, after which the young researcher has moved to a post-doc position in Germany.

2. The Valencia node has been able to use its training funds to deliver 40.5 months of training, ten and a half months more than in the contract.

3. The Barcelona node has delivered 32 months of training, 2 more than the contract deliverable.

4. Following the shift described in (1.), the Orsay node CNRS/IN2P3 was committed to 23 rather than 24 months of training, with one month given to the Frascati node.

5. The Durham node provided 49 months of training with 69% (rather than the contracted 50%) at the postdoc level. This was done with the approval of the EU project Officer.

6. The post-doc appointed by the DESY Zeuthen node, Dr. Michal Czakon, left earlier having obtained a permanent position. The remaining training months at this node were assigned to the Karlsruhe subnode where A. Grzelinska was hired for the period October 1st 2005 - August 30th 2006.

7. The Lund node has been able to finance the young researcher Timo Lähde for a period of 24 months rather than the originally funded 13, through obtaining for the young researcher a tax free status from the Swedish government.

8. The Vienna node was able to use its funds to increase its training from 24 months to 26 months.

9. The Bern node, whose training deliverable was financed by the Swiss Government, delivered 23 rather than 24 months of training, because the young reearcher was offred a 6 year position at University of Bonn and hads to leave one months earlier for teaching duties.

Table 5: Training

Participant	Contract deliverable to YR to be financed by the contract (person-months)			YR financed by the contract up to 31/08/2005 (person-months)			Delivered during fourth period (person-months)
	(a)	(b)	(a+b)	(c)	(d)	(c+d)	
1.INFN-LNF	24	24	48	R. Unterdorfer 9 S. Tsatis 3	C. Smith 23 S. Trine 11	46	S. Trine 4 C. Smith 1
2.UVEG		30	30		J. Hirn 11	11	J. Hirn 12 F. Jugeau 12 R. Bonciani 5,5
3.UAB		30	30		B. Hiesmayr 6 I. Scimemi 6 M. Verbeni 20	32	
4.CNRS-DR12		24	24		S. Necco 23	23	S. Necco 1
5.CNRS/IN2P3		24	24		J. J. Sanz-Cillero 12	12	J. J. Sanz-Cillero 11
6.DUR	24	24	48	J. Hirn 12 K. Benhaddou 2 M. Pappagallo 1	L. Edera 10	25	L. Edera 3 M. Pappagallo 10 Roamn Zwicky 11
7.ULUND		13	13		T. Lähde 23	23	T. Lähde 1
8.UHELS		13	13		B. Julia-Diaz 13	13	
9.DESY Zeuthen		24	24		M. Czakon 13	13	A. Grzelińska 11
10.UNIBE		24	24		B.Kubis 23	23	
11.UWIEN.IT		24	24		R. Kaiser 23 J. Schweizer 1	24	R. Kaiser 1 J. Schweizer 1
TOTAL	48	254	302	27	218	245	84.5

Comment on the state of training

We notice that during the last period the network has delivered 84.5 additional months, bringing the total delivered training to 329.5 person-months, almost 10% larger than the contract deliverable financed by the contract (302 person-months in total).

The details of the above training, for the entire period covered by the contract can be found below. For each young researcher we indicate

- Name
- Type of training
- Date of birth
- Nationality
- Start of contract-end of contract
- Duration of Contract
- Position taken by the researcher after leaving the network contract.

1. **INFN-LNF : 48 months in contract-51 months delivered**

   Rene Unterdorfer

   Pre-doc (PhD thesis with G. Ecker, scientist in charge of the Vienna node)

   Birth date: 19-02-1976

   Austrian

   September 1st 2003 - May 31st 2004

   9 months

   Post-doc at PSI, Switzerland

   ****

   Christopher Smith

   Post-doc

   Birth date: 08-04-1974

   Belgian and French

   October 1st 2003 - September 30th 2005

   24 months

   Post-doc at University of BERN

   ****

   Stratos Tstatis

   Pre-doc (PhD thesis with Y.N. Srivastava from Perugia University, part of INFN node)

Birth date: 02-03-1978

Greek

April 30th 2004 - July 31st 2004

3 months

Graduate student at Northeastern University, Boston, USA

****

Stephanie Trine

Post-doc

Birth date: 29-11-1976

Belgian

October 1st 2004 - December 31st 2005

15 months

Post-doc at University of Karlsruhe, Germany

2. **Universidad de Valencia : 30 months in contract- 40,5 months delivered**

Johannes Hirn

Post-doc

Birth date: 03-10-1977

French

October 1st 2004 - August 31st 2006

23 months (+1 outside Euridice)

Post-doc at University of Yale, USA

****

Frederic Jugeau

Post-doc

Birth date: 28-05-1975

French

September 1st 2005 - August 31st 2006

12 months

Post-doc at INFN-Bari, Italy

****

Roberto Bonciani

Post-doc

Birth date : 19-02-1970

Italian

September 15th 2005 - February 28th 2006

5.5 months (+ 18 months outside Euridice)

Post-doc at University of Valencia

3. **UAB Universitat Autònoma de Barcelona : 30 months in contract-32 months delivered**

   Name: Beatrix C. Hiesmayr

   Post-doc

   Birth date: 27-01-1975

   Austrian

   February 1st 2003 - July 31st 2003

   6 months

   Postdoc at the Institute of Experimental Physics,

   U. of Vienna (01.08.2003-31.12.2003).

   Assistant at the Institute of Theoretical Physics,

   U. of Vienna (01.04.2004-31.03.2010)

   ****

   Ignazio Scimemi

   Post-doc

   Birth date: 09-09-1969

   Italian

   October 1st 2003 - March 31st 2004

   6 months

   Contract researcher at U. of Valencia and IFIC, U. of Valencia.

   ****

   Michela Verbeni

   Post-doc

   Birth date: 16-06-1970

   Italian

   November 1st 2003 - June 30th 2005

   20 months

   Visiting Researcher at Fundacion Seneca, U. de Murcia (18.01.2006-17.01.2007)

4. **Marseille : 24 months in contract-24 months delivered**

   Sylvia Necco

   Post-doc

   Birth date: 26-05-1974

   Italian

October 1st 2003 - September 30th 2005

24 months

Post-doc at University of Valencia

5. **CNRS-IN2P3 : 24 months in contract-23 month delivered**

   Juan Jose Sanz-Cillero

   Post-doc

   Birth date: 16-10-1976

   Spanish

   October 1st 2004 - August 31st 2006

   23 months

   Continuing post-doc position at CNRS

6. **U. of Durham : 48 months in contract-49 months delivered**

   (contract for 24 months predoc, 24 months postdoc — 49 months delivered : 15 months predoc, 34 months postdoc)

   Johannes Hirn

   PhD Student

   Birth date: 03-10-1977

   French

   October 1st 2003 - September 30th 2004

   12 months

   Next position: Postdoc in Valencia

   ****

   Kamel Benhaddou

   PhD Student

   Birth date: 20-11-1973

   French

   October 1st 2003 - November 30th 2003

   2 months

   Next position: financial sector employment

   ****

   Laura Edera

   Post-doc

   Birth date: 02-02-1975

   Italian

   November 1st 2004 - December 1st 2005

13 months

Next position: CERN Fellow from January 2006

****

Marco Pappagallo

PhD student

Date of Birth: 20-06-1977

Italian

June 1st 2005 - June 30th 2005

1 month

Next position: returned to Bari to complete PhD

****

Marco Pappagallo

Post-doc

Date of Birth: 20-06-1977

Italian

November 1st 2005 - August 31st 2006

10 months (+1 outside Euridice)

Next position: Postdoc contract at Durham extended for 7 months till 31st March 2007

****

Roamn Zwicky

Post-doc

Date of birth: 15-05-1972

Swiss

October 1st 2005 - August 31st 2006

11 month

Next position: Postdoc contract at Durham extended for 25 months till 30th September 2008

7. **U. of Lund : 13 months in contract-24 month delivered**

   Timo Lähde

   Post-doc

   Birth date: 30-07-1977

   Finnish

   October 1st 2003 - September 30th 2005

   24 months

   Postdoc at University of Bonn, Germany

Note : The above 24 months refer to the fact that it was possible to obtain a tax free status for the young reseracher which allowed to use EU funding for support for 24 months.

8. **U. of Helsinki : 13 months in contract-13 months delivered**

   Bruno Julia-Diaz

   Post-doc

   Birth date: 13-09-1975

   Spanish

   June 1st 2003 - June 30th 2004

   13 months (16,5 months)

   Note : For the duration, the number (13 months) is the one from contract. The Helsinki node has covered additional 3,5 months from local sources

   Post-doc at Saclay after leaving the network, presently at University of Barcelona

9. **DESY-Zeuthen : 24 months in contract-24 months delivered**

   Michal Czakon

   Post-doc

   Birth date: 11-04-1974

   Polish

   October 1st 2003 - October 30th 2004

   13 months

   Tenure position at University of Würzburg, where he is leading his own research group funded by the Alexander von Humboldt foundation (Sofja Kovalevskaja Award for 3 years ending 2007)

   ****

   A. Grzelińska

   Post-doc

   Birth date: 26-07-1975

   Polish

   October 1st 2005 - August 30th 2006 at University of Karlsruhe

   11 months

   Continuing as postdoc at University of Karlsruhe

10. **U. of Bern : 24 months in contract-23 months delivered**

    Bastian Kubis

    Post-doc

    Birth date: 06-02-1974

    German

November 1st 2002 - September 30th 2004

23 months

Assistant (6 year position) at University of Bonn

11. **U. of Vienna : 24 months in contract-26 months delivered**

    Roland Kaiser

    Postdoc

    Birth date: 17-02-1972

    Swiss

    October 1st 2003 - September 30th 2005

    24 months

    Post-doc at CNRS-Luminy Marseille

    ****

    Julia Schweizer

    Postdoc

    Birth date: 15-05-1975

    Swiss

    August 1st 2005 - September 30th 2005

    2 months

    Insurance Company Allianz Suisse (Bern)

2.5.3 B.5.3 Integration into the research program

All the young researchers have been fully integrated in the research programme, most of them have published their results in refereed journals or in the form of electronic preprints and the relative papers have been submitted for publication in the international journals. All the young reearchers have had the opportunity to participate to the Collaboration meetings, present their work and interact with the senior scientists.

2.5.4 B.5.4 Training measures

The measures undertaken in the training program concerned both individual and common training. Common training was performed through attendance to the Frascati Spring School, participation and attendance to the Collaboration Meetings and participation to the topical Workshops dedicated to the research topics of interest for the young researcher. Individual training consisted in collaboration exchanges and secondments to other nodes to work on common projects.

2.5.5 B.5.5 Promotion of equal opportunities.

The network has had a good proportion of women in leading positions, since 4 out of the 17 members of the Executive Committee were women, namely the Coordinator, the scientist in charge of the Warsaw node, the scientist in charge of the Granada team and the KLOE experiment analysis coordinator. Their presence in high management and research positions has certainly increased the visibility of women in the field.

Among the 23 young researchers trained during the entire period of operation, 7 of them were women, representing a proportion of 30% young women scientists, higher than what is usually reported for the presence of women in the field of theoretical physics (according to INFN statistics of the year 2000, in Italy only 11% of the total number of theoretical particle physicists with permanent positions were women).

Special attention has been devoted in all the nodes to training and retaining of young women physicists, by extending their contract whenever possible so as to allow flexibility for special personal needs. We consider that the presence of women in leading positions in this network has increased the awareness of all the node scientists to the special plight of women physicists and that this reflects the good record in training of young women researchers.

2.5.6 B.5.6 Multidisciplinarity

This is a network in theoretical particle physics with phenomenological applications. From this point of view, multidisciplinarity is hard to be included. We can however notice that the close collaboration between experimentalists and theorists in our network already allows for a large and partly unique exchange between different fields in the same discipline. In addition, the training in the field of Quantum Mechanics, an important component of the research effort of the the Barcelona and Vienna node, has involved a certain degree of interdisciplinarity.

2.6 B.6 Difficulties and changes w.r.t the contract

No difficulties have been reported. A change in the distribution of funds has been approved by the network (and communicated to the EU officer), whereupon one month of training funds has been transferred from the Orsay (CNRS-IN2P3) node to Frascati (INFN/LNF), to complete training of the young researcher Stephanie Trine. This transfer of funds, to which all the nodes were in agreement, allowed a continuation of three more month to the training of this young woman researcher.