



FROM DAPHNE TO EURODAPHNE TO EURIDICE

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INFN-LNF
Kazimierz, 24th august 2006
EU-HPRN-CT-2002-0311



We have come a long way



THANKS

To our Polish hosts and friends

Maria and Henryk

Who have spent these months worrying for
us and organizing this meeting!

I HAVE BEEN HERE MANY TIMES SINCE 1983 AND ALWAYS ENJOYED THE
PLACE AND THE FRIENDS

Like when we used to take long
walks in the countryside



August 24th, 2006

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KAZIMIERZ HAS ALWAYS BEEN A GREAT PLACE TO GO TO ...

Even when, like in
May 1984, the bus
would broke down
midway between
Kazimierz and
Warsaw...

August 24th, 2006

G.Pancheri



AN OVERVIEW

1992: The initial DAFNE theory group was put together by INFN to provide theoretical and phenomenological support for the experiments to be done at the new ϕ -factory

- **Two DAFNE handbooks were written**
 - **1992**
 - **1995** 800 pages on the web available electronically to the community [**N.B. true again now**]
- **Two EURODAPHNE Networks were funded by EU**
 - **HCM 1992**
 - **TMR 1998**
- **The RTN EURIDICE network was funded by EU in 2002**
- and now FlaviaNet in 2006!

A BIT OF HISTORY : STARTING FROM THE 50'

1953 the newly funded INFN approved the construction of an electrosynchrotron and two years later decided to built it in a site close to Rome, in what was still the countryside, ai “castelli”, more precisely in Frascati. Why was the Frascati site chosen?

As the story goes, the land was offered by the municipality because of a connection to Cardinal Pietro Micara, one of the most powerful Church figures in postwar Italy for many years and a native of the area.

AS TOLD BY TOUSCHEK IN 1974

2. The Birth of Ada. Frascati is a small town, about 20km from Rome, one of the "Castelli Romani" the Roman castles, situated on the north slope of the "Tuscolo", a small hill, prelude to the impressive mountains which form the spine of Italy. On the plain just underneath the town there are the "National Laboratories" of Frascati (Laboratori Nazionali del Frascati = LNF.). Until June 1955 there was nothing except dark shrubs and scattered vineyards which produced a sentimental wine dear to the Romans. There was a dust road leading up to the place and there was no water. The nascent laboratories had to wait till 1957, when a well desperately driven to near the antipodes started to promise a sufficient yield.



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TOUSCHEK'S UNTHINKABLE PROPOSAL

- In 1960 Touschek proposed to build in Frascati an accelerator in which **positrons** would collide head-on with **electrons**
- Particles against antiparticles : the annihilation would produce the release of **energy from the vacuum**, namely complete transformation of matter into energy

ADΛ

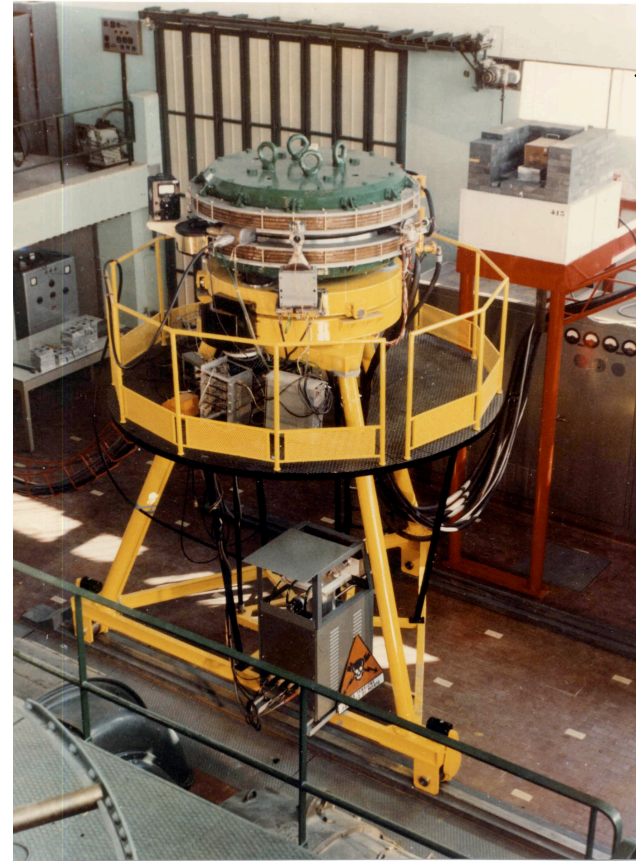
- The machine was made in **1 year**
- Touschek liked the name **AdA** (like his aunt) to mean **Anello di Accumulazione**

(Storage Ring because of the large number of needed accumulated electrons and positrons)



THE CONTRIBUTION OF BRUNO TOUSCHEK : ADA

- Bruno Touschek is remembered in the history of accelerators as the scientist who in 1960 first proposed, designed and contributed to build the first matter-antimatter accelerator



AFTER ADA CAME ADONE

- At the end of 1960 a proposal to build a bigger machine was put forward and the chosen name was

ADONE = big AdA

- Adone was operational in **1969**
- Discovered the **multihadronic** production
- In **november 1974** confirmed within 3 days the discovery of the J/ψ
- Became a **synchrotron** light source from **1976**
- Was again turned into a e^+e^- machine from **1989 to 1993** with the FENICE experiment for nucleon-antinucleon production



Bruno Touschek during
the construction of
ADONE

IN THE MEANWHILE, IN 1990, CP
VIOLATION HAD BECOME A VERY
HOT RESEARCH TOPIC

- After NA31 and E731 experimental results on π/π , studies developed in many places to examine the possibility of measuring it again with higher precision and push the theoretical estimate as well
- And INFN started its own assessment of the scope of π -factory, to see what else one could use it for, beyond π/π

1990: THE REPORT FROM THE PHI-FACTORY WORKING GROUP

- In 1990 Cabibbo, then INFN president, asked a group of Italian theorists to study the physics import of a phi-factory **independently** of ϕ/ϕ

- R. Barbieri
- L. Maiani
- G. Martinelli
- N. Paver
- R. Petronzio
- E. Remiddi

The report LNF-90/041, 29 maggio 1990, addressed the following topics



- Kaon physics and chiral Lagrangians
- Leptonic and semi-leptonic decays and related processes
- Decays involving the non-leptonic Hamiltonian, with photons or lepton pair emission
- CP violation in charged kaons
- Total cross-section and hadronic contribution to the muon $g-2$
- Spectroscopy

KAON PHYSICS AND CHIRAL LAGRANGIANS IN THE 1990 REPORT

□PT

- “recently several authors [Gasser and Leutwyler...] have provided an extension of the theoretical analysis to the first next order terms in the chiral lagrangian ($m^4, p^4, m^2 p^2$)..”
- “At the present level many of the theoretical predictions have not been checked experimentally”

K- decays

“An experimental clarification of discrepancies observed in K_{l3} decays is of paramount importance...”

Etc.

THE LIGHT-BY-LIGHT DISCUSSION IN THE 1990 REPORT

$49 \pm 5 \cdot 10^{-11}$ Kinoshita et al. 1985

i) $a(\gamma, h\gamma)_{\text{quarks}} = 60 \pm 4 \cdot 10^{-11}$ with
 $m_u = m_d = 0.3 \text{ GeV}$,
 $m_s = 0.5 \text{ GeV}$,
 $m_c = 1.5 \text{ GeV}$

ii) while with mesons

$$a(\gamma, h\gamma)_{\text{mesons}} = 49 \pm 5 \cdot 10^{-11}$$

To estimate the effect of a choice of the quark masses, the following argument was given:

- For a quark of charge Q and mass $m \gg \text{muon mass}$, the contribution to a_γ from V.P. would be consistent with (at the time) present data using
 $- m_u \sim 0.18 \text{ GeV}$

But this would imply

$$a(\gamma, h\gamma)_{\text{quarks}} \sim a(\gamma)_{\text{weak}}$$

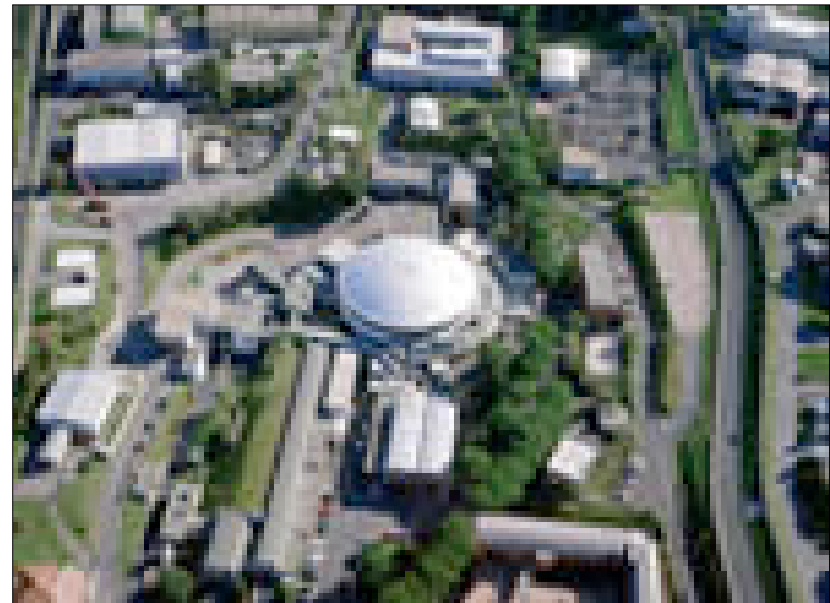
SPECTROSCOPY IN THE 1991 REPORT

- Direct production of 1^{--} states in the 1-2 GeV range
- States obtained through π -decays
- States from $\pi\pi$ interactions
- Scalars in radiative π -decays: B.R. in the range 10^{-4} to 10^{-6} can distinguish between
 - Quarkonium
 - Glueball
 - KK molecule
- Mixing in π, π'
- Scalar and tensorial states in $\pi\pi$

SOME MORE HISTORY

Following the 1991 report, INFN approved the construction of a high luminosity e^+e^- machine at the c.m. energy $=m_\chi$ to study

- CP violation
- Rare K-decays
- Hadronic contributions to the muon anomalous moment
- Spectroscopy from $\chi\chi$ decays



THE EXPERIMENTS AT DAΦNE

- **KLOE** : **K** Long **O**bservation **E**xperiment
 - Particle physics studies at the ϕ -factory
- **DEAR** : **D**aΦne **E**xotic **A**toms **R**esearch
 - Kaonic atoms formed with Kaons from DAΦNE
- **FINUDA** : **F**isica **N**ucleare a **D**AΦne
 - Nuclear physics K N system (K mesons from ϕ -decays) hypernuclei formation and decay

THE DAPHNE THEORY GROUP

- In **April 1991** the first Workshop on Physics and Detectors for DAPHNE was held in Frascati
- The initial nucleus of the theory group was then enlarged to become the **Daphne theory group** whose mandate was to prepare a Report with all useful formulae derived anew and revisited in view of an up-to-date assessment of what could be expected to be done at DAPHNE
- It was decided to complete the Report within one year and in **june 1992** the **DAPHNE PHYSICS Handbook** was published
- In May of that same year, Pennington suggested to try out for the EU programs, at the time, the **Human Capital and Mobility Program** HCMP

THE DAPHNE THEORY GROUP IN 1992 OR...WHEN WE WERE YOUNG



A. Bramon

August 24th, 2006

J. Bijnens

G. Ecker

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J. Gasser

G. D'Ambrosio

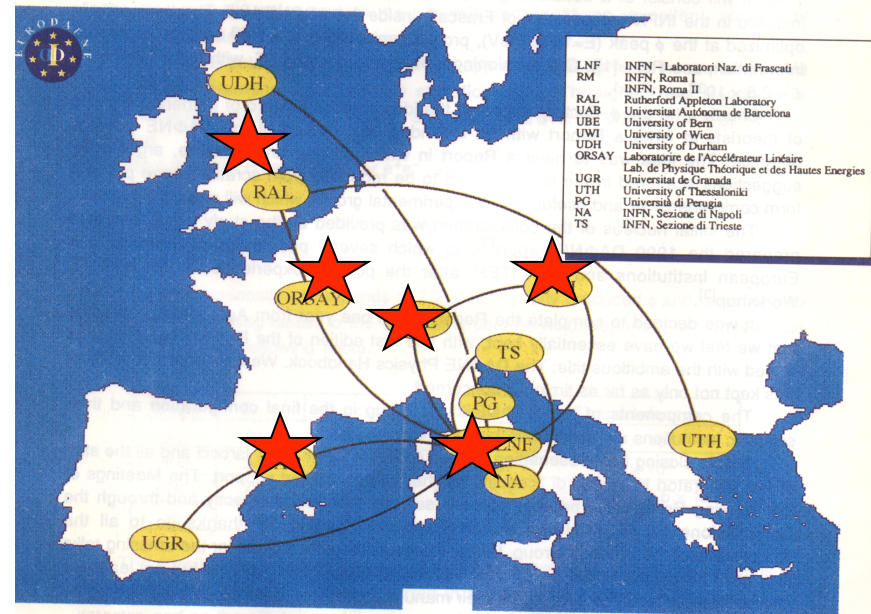
M. Pennington

G. Isidori

AND TRY WE
DID...

- Mike Pennington suggested the name EURODAPHNE
- Gerhard Ecker suggested that I start writing the proposal
- Frank Close suggested to add Orsay and Thessaloniki

And, in november 1992, we were funded with some ~ 450k€



The EURODAPHNE Collaboration Network
Partly supported by ECC Human Capital and Mobility Program
Contract ERBCHRXCT920026

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EURODAPHNE 1 : 1992-1996

- INFN Rome1 - L. Maiani
- INFN-Rome2 - R. Petronzio
- **LNF** - G.P.
- Trieste - Nello Paver
- Perugia - Paolo Gensini
- Naples - Giancarlo D'Ambrosio
- **Bern** - Juerg Gasser
- **UAB** - Alberto Bramon
- Granada - A. Grau
- Orsay - Lluís Oliver
- **LaL** - Andre' Courau
- **Rutherford Lab** - Frank Close
- Durham - Mike Pennington
- **Wien** - Gerhard Ecker
- **Thessaloniki** - George Gounaris

August 24th, 1996

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R. Alzetta
S. Bertolucci
T. Barnes
A. Bramon
T. Bressani
F. Close
G. Colangelo
G. D'Ambrosio
E. Gabrielli
J. Gasser
P.K. Kabir
G. Martinelli
A. Molinari
H. Neufeld
O. Nicosini
S. Ong
G. Pancheri
N. Paver
M. Pennington
M. Preger
E. Shabalin
Y.N. Srivastava
J. Stern
A. Zallo

Secretariat:

M.C. D'Amato



SO WE DECIDED TO WRITE AN UPDATED VERSION OF THE HANDBOOK

- Some of the physics items were only slightly updated from the first handbook

But there were also totally new parts

like

- $\pi\pi$ scattering
- new emphasis on $\pi\pi$ with the Israeli group
- radiative corrections



II EURODAΦNE Collaboration Meeting
Frascati, 19–22 April, 1994

August 24th, 2006

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AND AFTER MANY MEETINGS...

In Durham **december**
1994 we had a wonderful
time and the started its
long difficult way back
into particle physics, to
reappear through a talk by
Christopher Bruno on the
Extended Nambu-Jona-
Lasinio Model

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- | | |
|-------------------|-------------------|
| 1. P. Gensini | 13. A. Grau |
| 2. B. Moussallam | 14. J. Stern |
| 3. O. Panella | 15. M. Pennington |
| 4. G. Isidori | 16. M. Finkemeier |
| 5. R. Alzetta | 17. A. Pugliese |
| 6. N. Paver | 18. C. D'Amato |
| 7. R. Urech | 19. A. Courau |
| 8. C. Bruno | 20. J. Portolés |
| 9. S. Bellucci | 21. A. Bramon |
| 10. M. Knecht | 22. G. Pancheri |
| 11. G. D'Ambrosio | 23. G. Colangelo |
| 12. M. Nowakowski | 24. D. Morgan |

Absent : F. Close

III EURODAΦNE Collaboration Meeting, University of Durham, 10–15 December, 1994
Courtesy of M.R. Pennington



Partly supported by ECC Human Capital and Mobility Program Contract ERBCHRXCT920026

IN DURHAM WE ALSO SAW UNFORGETTABLE SUNSETS



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1995: THE SECOND DPH

- In 1995 a second **Workshop on Physics and Detectors for DAPHNE** was held in **Frascati** where the Seconds DAPHNE Physics Handbook was presented and put on the web in 3 formats
 - **Tex**
 - **Ps**
 - **Html**

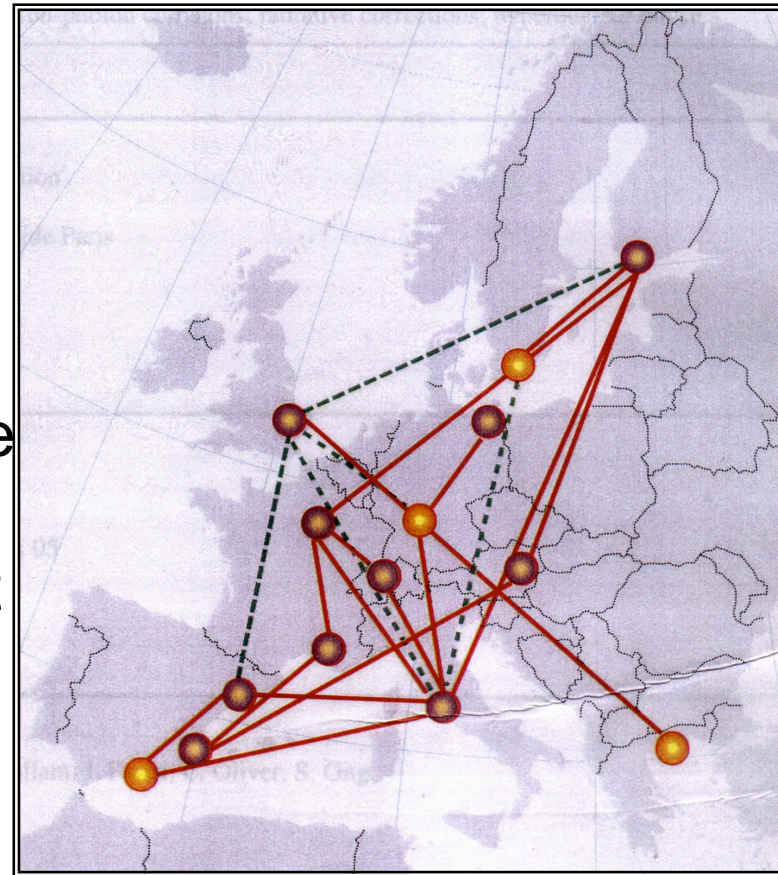
Lluís Oliver could not come to the meeting, but he sent a postcard

*I am sending
Stern and
Knecht
to the meeting...*



AFTER EURODAPHNE I

- In 1995 we applied for a second network, with no success
- In fall 1996 Gasser and myself went to Bruxelles (my first time...) to get some tips from the then officer in charge
- In january 1997 we put up a serious proposal writing effort and EURODAPHNE II was approved



THE KARLSRUHE MEETING







August 27th, 2000

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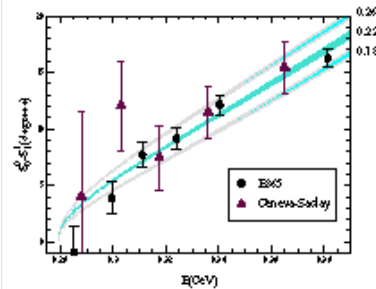
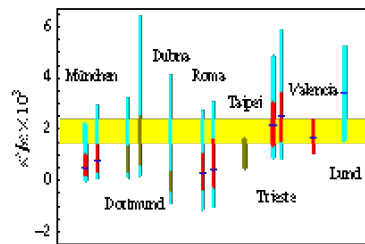
20

EURODAPHNE 2 : 1998-2002

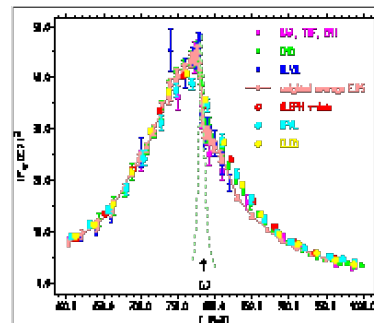
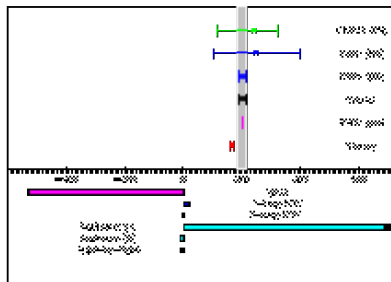
- LNF
[+Rome1, Torino, Perugia, Naples, Trieste]
- UAB
 - Granada
- Valencia 
- Marseille 
- Orsay
- Durham
 - Oxford
- Wien
- DESY-Zeuthen 
 - Karlsruhe
- Helsinki 
 - Lund
- Bern
 - Zurich

STATE OF THE ART IN 2001 FOR SOME FUNDAMENTAL COMPARISONS OF THEORY VS EXPERIMENTS

α/α



- α/α for CP violation
- pion scattering lengths as a test of ChPT



- g-2 of the muon
- Pion form factor

AND THEN CAME EURIDICE



A drawing
By
Lluís Oliver

August 24th, 2006




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31

THE EURIDICE NETWORK: 2002-2006

1. INFN-LNF
2. University of Valencia
3. Universitat Autònoma de Barcelona
4. CNRS-DR12 in Marseille Luminy
5. CNRS/IN2P3 in Orsay
6. University of Durham
7. University of Lund
 - University of Oslo
8. University of Helsinki
9. DESY Zeuthen
 - University of Karlsruhe
10. University of Bern
11. Universität Wien
12. University of Warsaw



-  core teams
-  participants
-  subcontractors

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EURIDICE MAIN RESEARCH PROJECTS

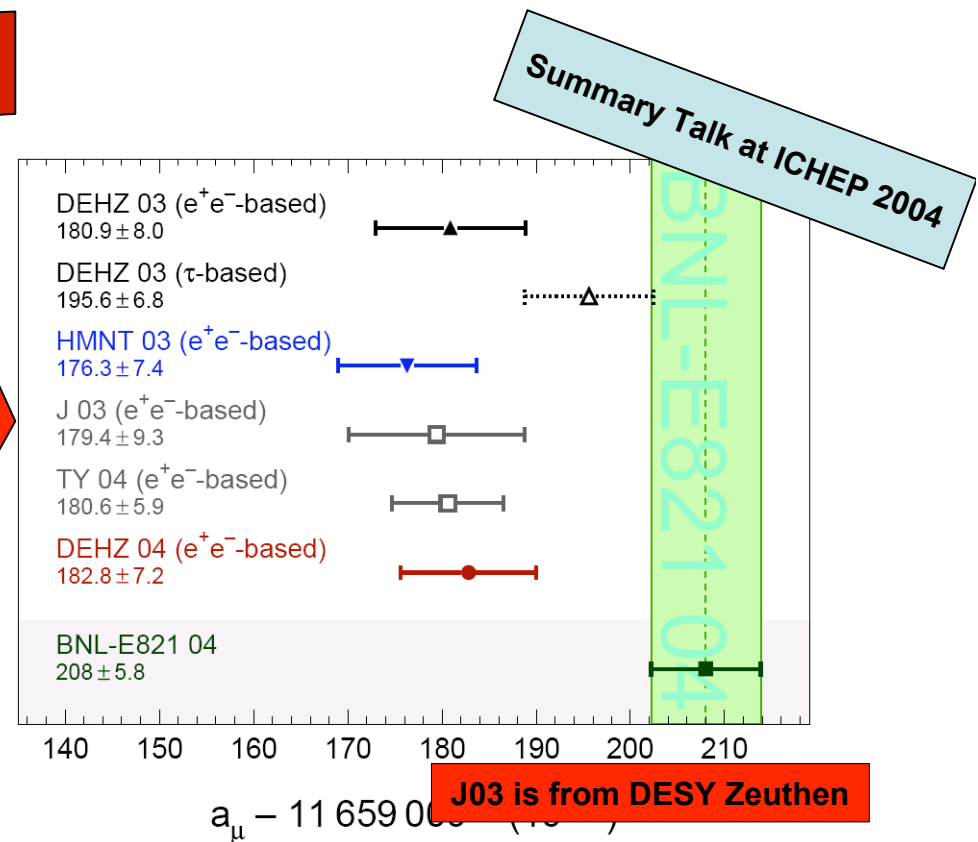
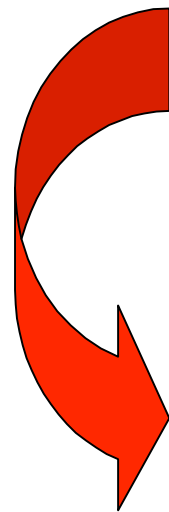
- CP-violation and Cabibbo-Kobayashi-Maskawa matrix determination
- Sharpening the predictions of Chiral Perturbation theory
- Quantum Mechanics in the Kaon system
- Determination of quark masses
- The energy dependence of the fine structure constant $\alpha_{\text{em}}(M_Z)$, the anomalous magnetic moment of leptons and other electroweak parameters
- Heavy flavour decays and Heavy Quark Effective Theory (HQET)
- Strong interaction limit of Quantum Chromodynamics

HIGH PRECISION

The network(s) have been instrumental in pursuing a **quest for high precision** in particle physics which

- Is at the basis of new discoveries
- Has sharpened enormously the theoretical tools

One example for all :
the muon anomalous magnetic moment



EURIDICE NETWORKING : MEETINGS AND WORKSHOPS

☀ Collaboration Meetings

- ✦ Topical Workshops
 - Chiral Dynamics
 - Sigma Hadronic
 - Hadronic Atoms
 - Hadronic Spectroscopy



Yearly :
LNF Spring School

August 24th, 2006

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36

AND NOW LET US MOVE ON TO EURIDICE FINAL TALKS



August 24th, 2006 **Durham Collaboration Meeting 1994**

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