

NBODY HAS EVER BUILT A MUON MACHINE
AND PROBLEMS SEEM OVERWHELMING
IF ADDRESSED ALL AT ONCE.

3 POSSIBLE STEPS

1. NEUTRINO FACTORY
only known source of high-energy ν_e

2. HIGGS FACTORIES
Lepton colliders with outstanding and reasonable
Energy, energy spread + higgs couplings!
⇒ THE right machine to build for SUSY HIGGSSES

3. HIGH ENERGY FRONTIER.
high energy resonances and thresholds
(no Beamstrahlung!)

EACH OF THESE STEPS HAS A BEAUTIFUL PHYSICS
PROGRAMME IN ITS OWN RIGHT !

ONE YEAR AGO: ECFA-1998

The conclusions of the prospective study can be stated as follows

1. The line of facilities using MUONbeams seems extremely interesting, providing a very rich physics programme for many years.
2. We suggest to ECFA to recommend to the European particle physics community to take this option very seriously.
3. We arrive at a point where detailed simulations and design become necessary, fault of which the feasibility and competitiveness of the project cannot be ascertained.

4. A series of

ECFA-sponsored WORKshops

would be an adequate forum to undertake the detailed work that is necessary to design and evaluate more completely this project, with emphasis on the

NEUTRINO FACTORY

5. The design and even the construction of this line of machines could involve competences that are available throughout Europe. A dedicated collaboration involving european laboratories is necessary to go further, and could become extremely efficient.

Expression of Interest

for

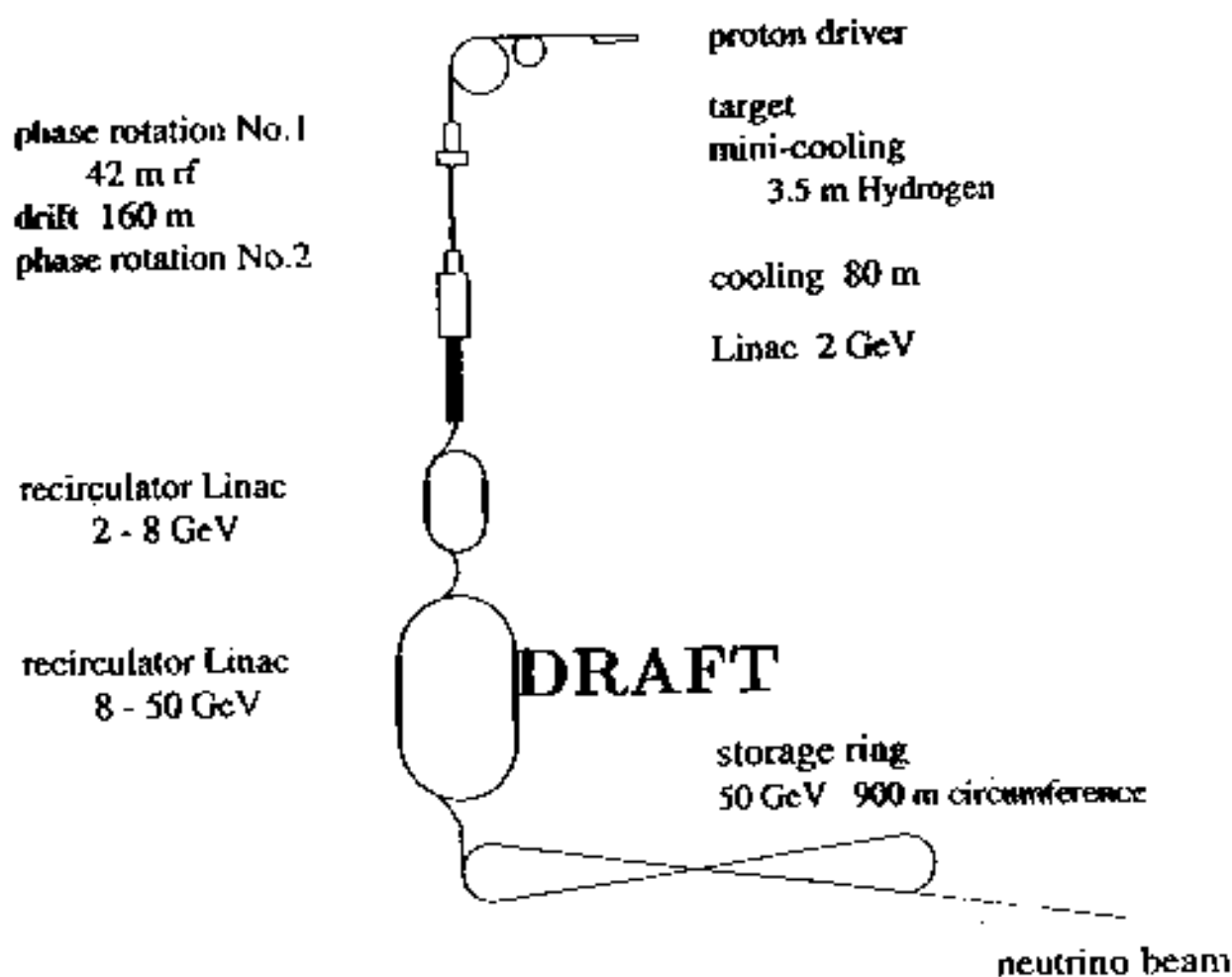
A Neutrino Factory Based On a Muon Storage Ring

Submitted to the National Science Foundation by

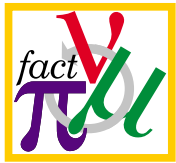
The Neutrino Factory and Muon Collider Collaboration

Collaboration Home Page: <http://www.cap.bnl.gov/mumu/>

(November 1, 1999)



This document resides at <http://puhep1.princeton.edu/mumu/NSFLetter/nsfmain.ps>

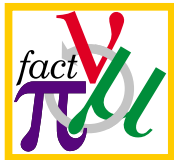


$$\mu^+ \rightarrow e^+ \nu_e \bar{\nu}_\mu$$

Expected Physics outcome of a Long base Line program
at a Neutrino factory

ν_e essential

- Measurements of θ_{13} , θ_{23} with precision of 10^{-4}
 - (10 KT, 4 MW on Target, 1 Year)
- Will be sensitive to CP violation over the whole Large Mixing Angle solution of the Solar neutrinos
 - (10 KT, 4 MW on Target, 1 Year -> begin to touch)
 - (50 KT, 20 MW on target, 5 years -> whole region)



Other physics opportunities at V-factory

Related to high intensity

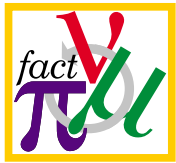
- short baseline neutrino experiments (standard fluxes $\times 10^5$)
 - DIS on various materials and targets
 - charm production
 - NC/CC $\rightarrow m_W$
- High intensity muon experiments
 - DIS,
 - rare muon decays and muon conversion (FCNC)
 - G_F , $g-2$, edm
- High intensity hadron experiments
 - rare K decays (e.g. $K^- \rightarrow \pi^0 \nu \nu$)

Step 1 towards muon collider(s)

Higgs and top factories

benefit from Higgs couplings ($\sigma_{\text{higgs}} \propto m^2$)
and superior energy calibration/resolution

Energy frontier (synergy with CLIC studies)



Going further....

1998: ECFA recommended "prospective study"

-> CERN 99-02, three-step scenario:

1. Neutrino Factory
2. Precision muon colliders
3. High energy frontier

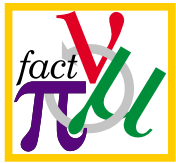
1999: ECFA recommended νFACT99 (emphasis on Neutrino Factory)

NUFACT'99 has emphasized the beautiful physics case...
and the fact that Neutrino Factory is a **WORLD MACHINE**
much remains to be done!

To place Europe in strong position in the promising domain of
intense muon beams and neutrino factory:

Pursue European-based effort with ECFA support

- > in close contact with efforts undertaken in US
- > build a strong and competent group in Europe



A strong European-based effort

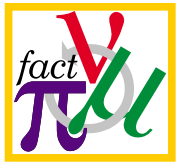
Suggested milestones:

1. **NUFACT00** 22-26 May 2000 Monterey (Ca, USA)
- > ECFA Sponsorship,
help Europeans to participate.

2. Towards the end of 2000: **ECFA studies** on

“A Neutrino Factory Complex:
Physics opportunities and
Outline of the machine”

3. A Pertinent **R&D** program



NUFACT 00, Monterey May 22-26 2000

Chair

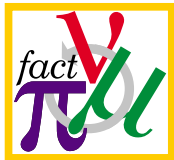
Stanley Wojcicki (SLAC),
Jonathan Wurtele (LBNL)

program committee

Bruno Autin (CERN)
Swapan Chattopadhyay (LBNL)
Yves Declais (IPNL Lyon)
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ECFA STUDIES -> END 2000

A Neutrino Factory Complex

Physics opportunities at the neutrino factory:

A. **Neutrino Oscillations** (F. Dydak, J.J. Gomez-Cadenas)

B. **High intensity** hadron, muon and neutrino beams (J. Ellis)

B1. ν and μ DIS (M. Mangano)

B2. Rare muon decays and muon physics (G. Giudice)

B3. High intensity Kaon physics (G. Buchalla)

Longer-term opportunities opened by the neutrino factory:

C. **muon colliders, High Energy Frontier**

(coordinated with CLIC studies: A. Blondel/J. Ellis/M. Battaglia)

In parallel with machine design studies by the

Neutrino Factory working group mandated by CERN (H. Haseroth)

+ High intensity superconducting proton linac (R. Garoby)

+ Rapid cycling synchrotron and accumulator (H. Schonauer)



A strong European effort

Meeting on R&D for High-Intensity Proton Accelerators in Europe
6-7 December 1999

Participation of experts from
DESY, Frankfurt, GSI Darmstadt, FZ Juelich
CEA Saclay, IPN Orsay
INFN Legnaro, INFN Naples, INFN Milano
RAL
PSI Villingen
CERN



European study groups

MUG (MUon steering Group)

Alain Blondel (U. Geneva)

Friedrich Dydak (CERN, EP)

Jonathan ELLIS (CERN,Th)

Jean-Paul FABRE (CERN,EP)

Helmut HASEROTH (CERN,PS)

Ken PEACH (Rutherford Appleton Lab, UK)

Paolo STROLIN (INFN Naples, Italy)

The members of MUG were chosen to represent as well as possible the community interested in Muon machines in EUROPE. As can be seen MUG counts people from members states and, at CERN, from accelerator physics, experimental physics, technical support and theory.

Membership will evolve with time as involvement spreads over a wider basis.

Alain Blondel is presently acting as contact/chair of MUG.



R&D Experiments in EUROPE

Coordinated with US

1. A hadron production experiment at the CERN-PS

This experiment aims at measuring the charged pion production by 2 - 16 GeV protons, data that are needed for a quantitative design of pion capture and phase rotation.

The very same experiment will be extended to hadron production by pions, so as to deliver the entire set of data that is needed for a reliable calculation of the atmospheric neutrino flux. **->on approval track: P315**

2. A large-angle muon scattering experiment

This experiment will measure with high precision the large-angle scattering of muons with momentum of a few hundred MeV/c in various materials including liquid hydrogen, as theoretical calculations are not reliable enough to assess the performance of ionization cooling of muons.

-> proposed (Triumph,PSI)

3. Exposure of an RF cavity to radiation and a magnetic field

One of the big unknowns is the reliability of operation of the RF cavities which are currently discussed for pion capture and phase rotation, and will have to operate in a high-radiation and possibly in strong solenoidal magnetic fields.

Also, experiments with pulsing RF cavities will be performed with a view to achieving higher gradients.

->in preparation at CERN

4. High-power target tests

Current design work is focussed on targets which withstand a beam power of 4 MW or even larger.

While not considered impossible, this is a daring goal for which, however, considerable know-how is available in Europe (CERN, GSI, KFA Julich, PSI, RAL), which can and should be channeled towards an interesting and

forward-looking challenge.

->CERN/RAL agreement



Requests to ECFA

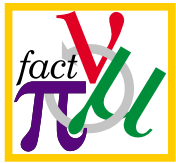
1. SPONSORSHIP of **NUFACT00**
2. ECFA sponsorship of European study groups on physics at **Neutrino Factory Complex**
3. Strong ECFA support/recommendation for European R&D and machine studies



Requests to ECFA

Recommendations of ECFA

1. SPONSORSHIP of **NUFACT00** **YES**
2. ECFA sponsorship of European study groups on physics at **Neutrino Factory Complex**
YES
3. Strong ECFA support/recommendation for European R&D and machine studies
at CERN and other laboratories in Europe



Upcoming general **muon** meetings

8-10 May at CERN

review of european coontributions to NUFACT00

22-26 May: V-FACT00 in Monterey (california)

10-12 July at CERN

drawing consequences of **V-FACT00**

23-25 October at CERN

preparation of ECFA report

<http://www.cern.ch/muonstoragerings>