cea

DAPNIA

DAPNIA-04-96

04/2004

A european megaton project at Fréjus.

L. Mosca

Talk given at the 8th International Workshop on Topics in Astroparticle and Underground Physics (TAUP-2003), Seattle (U.S.A.), September 05-09, 2003

Département d'Astrophysique, de Physique des Particules, de Physique Nucléaire et de l'Instrumentation Associée

DSM/DAPNIA, CEA/Saclay F - 91191 Gif-sur-Yvette Cédex

Tél : (1) 69 08 24 02 Fax : (1) 69 08 99 89

[http : //www-dapnia.cea.fr](http://www-dapnia.cea.fr)

TAUP 2003

Eight International Workshop on
Topics in Astroparticle and Underground Physics

September 5 – 9, 2003
University of Washington, Seattle, USA

A European Megaton Project at Fréjus

L. Mosca (CEA-Saclay) – Responsible of the Fréjus Laboratory Projects

Abstract

An International Facility project with a Megaton size Cerenkov as main Detector, in the Fréjus Deep Underground site, is presented. The physics program, MEMPHYS, includes both non-accelerator (proton decay, atmospheric and solar neutrinos, neutrinos from Supernovae, etc) and accelerator (neutrino oscillations with Super-beams and Beta-beams from CERN) experiments.

1. MOTIVATIONS

Some general motivations for this project are common to the other Megaton Projects in the world (USA and Japan) : Proton Decay ($p \rightarrow e^+ \pi^0$, $p \rightarrow K^+ \nu$, ...), Neutrinos from Natural Sources : Supernovae Watch, Atmospheric Neutrinos, Solar Neutrinos and Neutrinos from Accelerators : Long baselines (Super-beams, Beta-beams) for Neutrinos Oscillation studies.

Some additional motivations are specific to the “CERN-Fréjus” configuration:

- the great depth of the Fréjus site (4 800 mwe)
- the idea and hopefully the possibility of Neutrino Betabeam(s) (in addition to Superbeam(s) from CERN)
- the “magic distance” (130 km) between CERN and the Fréjus site for $\nu_\mu \leftrightarrow \nu_e$ Oscillation studies ($\theta(1,3)$, CP and T violation)

2. THE COMPONENTS OF THE PROJECT

Basically three components enter in this MEMPHYS (MEgaton Mass PHYSics) project (see on the next page an “artistic view” of whole complex) :

- a) **a very large Laboratory** ($\approx 10^6 \text{ m}^3$): this could be excavated nearby the present LSM laboratory, at a depth of 4800 mwe, taking advantage of a new “safety” tunnel to be excavated in the next years and allowing a very convenient access both for the large cavity excavation and for the running of the future experiments.
- b) **a Megaton Cerenkov Detector** : this could be, e.g., a “UNO” or “Hyperkamioka” type detector, optimized for the large variety of experiments mentioned above.
- c) **the Neutrino beam(s) from CERN**, situated at 130 km from the Fréjus site, an ideal distance for neutrino oscillation studies with both muon-(anti)neutrino Superbeams, of high intensity but of the “classical” type, and electron-(anti)neutrino “Beta-beams”, a new and original type of high quality neutrino beam, recently proposed and being developed at CERN. This “golden configuration” should allow the study of both CP and T violation in the lepton sector (see e.g. my talk in this conference on “Beta-beams from CERN to Fréjus” and references therein)

The basic idea of the strategy for the MEMPHYS project is to start, as soon as the new (safety) tunnel is completed (around 2008), the excavation of the large cavity and the installation of the megaton Cerenkov detector in order to start around 2015 the non-accelerator sector of the physics program. Then, when the different neutrino beams from CERN will be operational, the accelerator sector of the program could also start in parallel.

4. PRELIMINARY STUDIES and R&D

a) A preliminary study for a very large cavity ($\approx 10^6 \text{ m}^3$) at the Fréjus site will be performed in the next months, being co-funded by the DSM/CEA and IN2P3/CNRS French institutions, the Rhône-Alpes Region (France) the Piemonte Region (Italy) administrations, and probably with an additional contribution from a European network (Interreg).

Three objectives will be pursued :

- 1) the investigation of the feasibility conditions : this essentially implies the determination of the maximum possible size of the cavity for different types of geometry
- 2) the investigation of the compatibility conditions of this laboratory excavation and running with the characteristics of the new (safety) tunnel design
- 3) a rough estimate of the cost and time of the excavation.

Then a more detailed and extensive study will be performed with (hopefully) an important contribution from the European Community (EC Design Study)

b) The basic design and R&D for both Super-beam and Beta-beam complex did successfully start and will be pursued in the frame of the "BENE" (CARE) European Network and the EURISOL Design Study (for the Beta-beam). More detailed information on the status and perspectives of Beta-beams can be found in the recent paper "Beta-Beams : present design and expected

performances", by Jacques Bouchez, Mats Lindroos and Mauro Mezzetto (hep-ex/0310059 v1 30 Oct 2003 : talk presented at NuFact 03, 5th International Workshop on Neutrino Factories & Superbeams, 5-11 June 2003, Columbia University, New York).

c) An R&D on the Cerenkov detector is being started (light collection optimisation vs. cost) and every offer of cooperation is particularly welcome in this sector.

d) An Expression of Interest (EoI) for the MEMPHYS project is at the stage of a first draft and is still time to join us in the perspective of preparing a Letter of Intention (LoI) and then a proposal.

5. SUMMARY AND OUTLOOK

The Megaton Project at Fréjus (MEMPHYS) shows a number of favourable conditions, summarized here in the following "Seven virtues":

- 1) great depth of the Fréjus site (4 800 mwe)
- 2) good quality of the rock (hardness and absence of water problems)
- 3) possibility of excavating a Megaton-scale cavity
- 4) independent horizontal access by the new "safety tunnel (ready around 2008)
- 5) central geographical position of the Fréjus site in Europe
- 6) strong support from the local authorities (Regions Rhône-Alpes and Piemonte), from the two Fréjus Tunnel Companies and from the French minister of Scientific Research
- 7) and 'last not least' : a "magic distance" of the Fréjus site from CERN (130 km) well adapted to Neutrino Oscillation experiments with Superbeams and Betabeams.

All these very encouraging conditions should allow to develop a very competitive project at the megaton scale.