

**Villars CERN/SPSC meeting
22-28 September 2004**

**Status of the Project of a Large International
Underground Laboratory at Fréjus**

Possible site(s) and possible detectors

L. Mosca (CEA-Saclay)

Plan of the talk :

- 1) Motivations of the project
- 2) A cavity (or few cavities) of - 10^6 m^3 total volume
- 3) Possible site(s) in the Fréjus region
- 4) Possible detectors
- 5) Preliminary studies (laboratory feasibility)
- 6) An “optimal” schedule
- 7) Summary and outlook

1) Motivations

“Non-Accelerator Physics” :

- Proton Decay ($p \rightarrow e^+ \pi^0$, $p \rightarrow K^+ \bar{\nu}$, ...)
- Neutrinos from Natural Sources → Supernovae Watch
Atmospheric Neutrinos
Solar Neutrinos

“Accelerator Physics” :

- Neutrinos from Accelerators → Long baselines (Superbeams,
and Betabeams)
for Neutrinos Oscillation studies

“Non-Accelerator Physics”

- **One possibility : a Megaton-scale Cerenkov Detector**

-> No serious technical challenge, but two well known practical limitations :

- 1) water depth (pressure) limited to - 60 m for current 20" PMTs
- 2) finite attenuation length of Cerenkov light - 80 m in pure water at $\lambda = 400$ nm, as in Super-Kamiokande

-> Examples of expected performances :

a) for proton decay :

PMTs covering	Energy threshold	Exposure for a ($p \rightarrow e^+ \pi^0$) sensitivity of 10^{35} Years
10%	10 MeV	4 Mt.Years
20%	7 MeV	3 Mt.Years
40%	5 MeV	2 Mt.Years

b) for Supernovae neutrinos :

- > for a Supernova explosion at 10 kpc -> - 140 000 events
-> for a Supernova explosion at Andromeda -> - 3 0 events

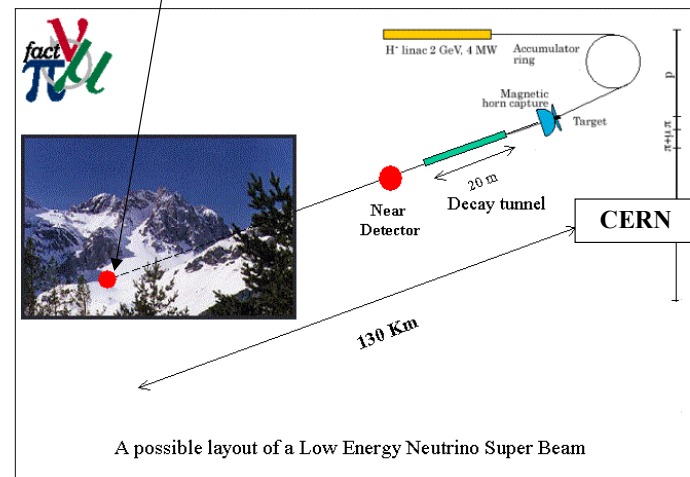
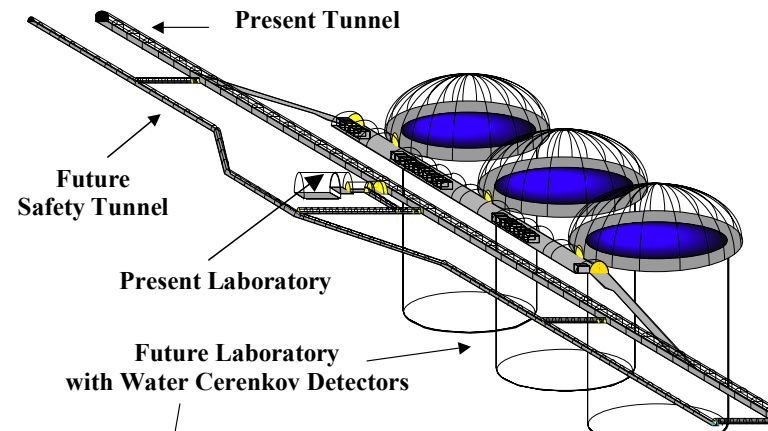
“Accelerator Physics”

A GOLDEN Experiment !

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décompresseur TIFF (non compressé)
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Components of the Project

-> a very large Laboratory to allow the installation of a
Megaton-scale Cerenkov Detector (- 10^6 m^3) and/or
 a **Liquid-Argon Detector**

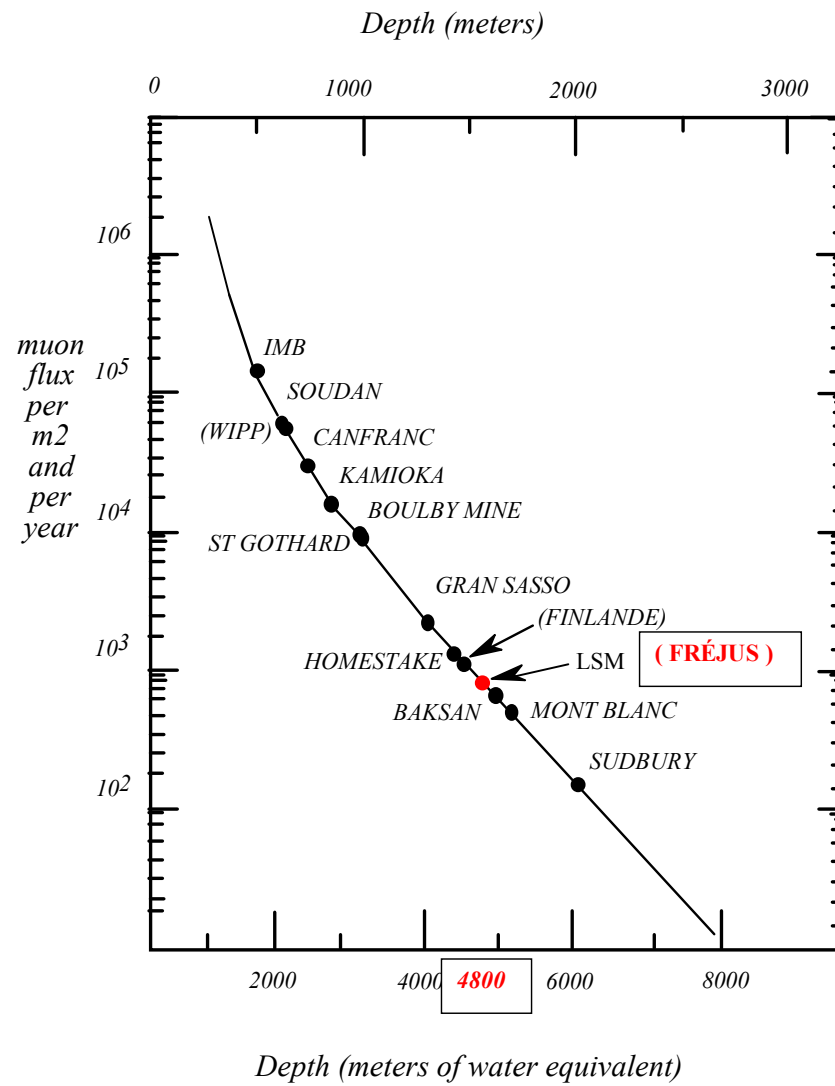


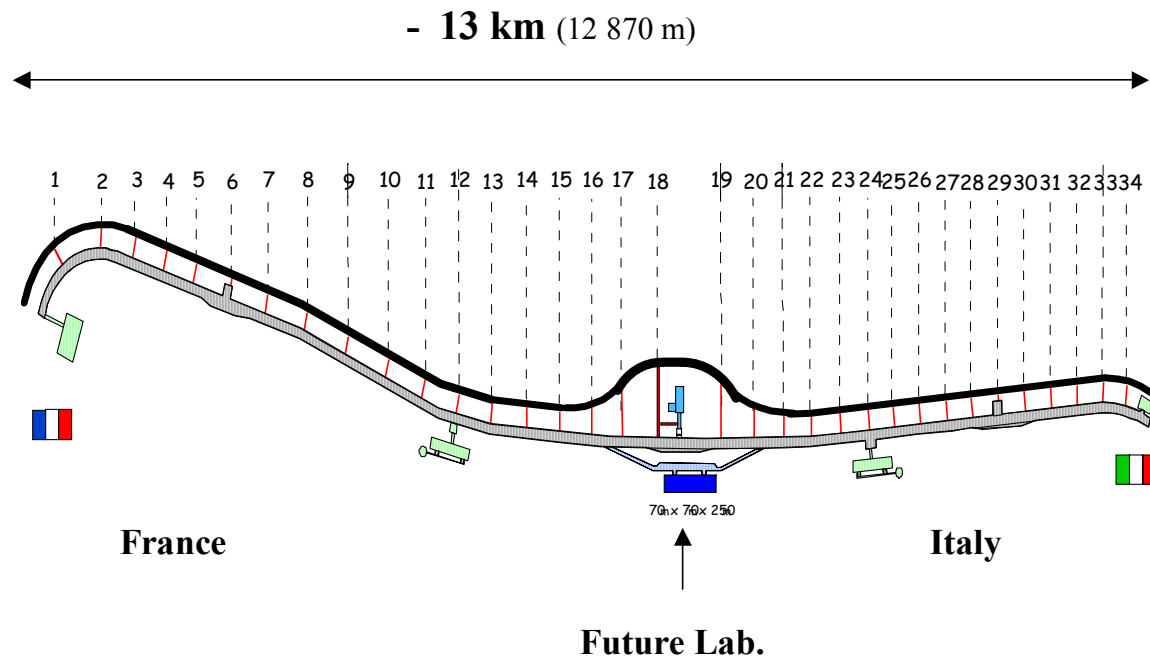
and (or) neutrino beta-beam

Possible sites in the **Fréjus** region

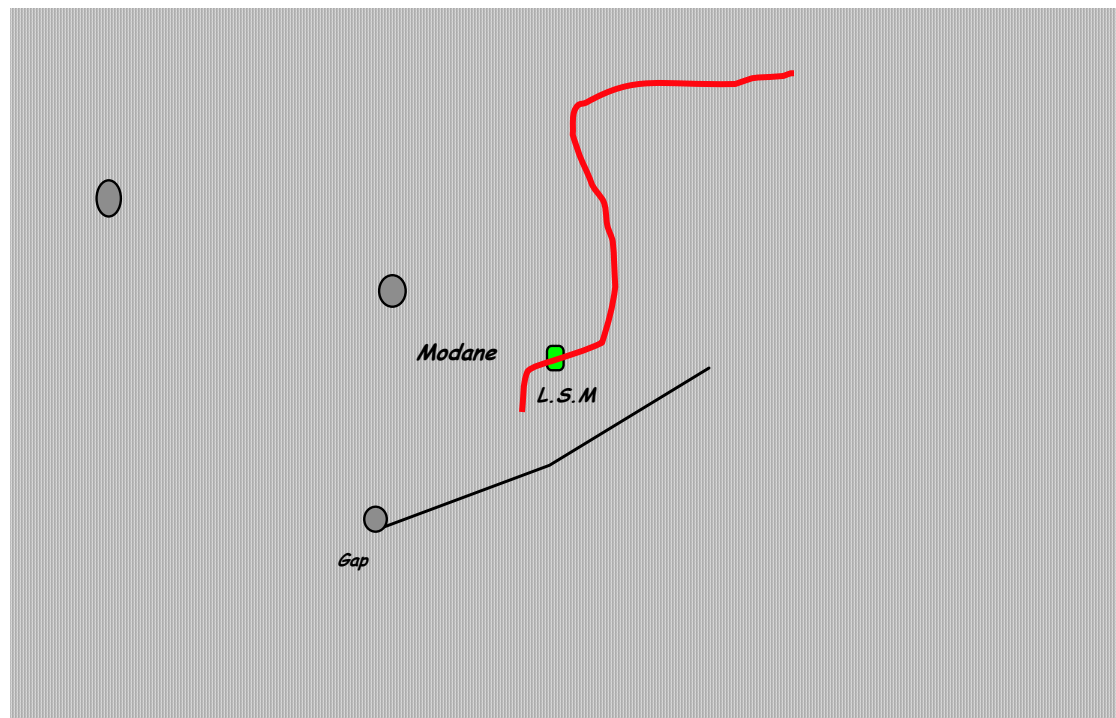
- our **“reference site”** is near the present Fréjus Laboratory (LSM), in the central region of the road Tunnel, at the French-Italian border with a good rock covering of **4800 mwe**
Here the rock is very dry, of good quality and rather well known
- **another site** (Mont d’Ambin) at about 15 Km in the East direction from the previous one, in a future access from the Italian side to the “Lyon Turin Ferroviaire” long Tunnel, has been proposed to us: here the rock is not yet systematically studied with some possible water problems (glaciers above)

Both sites are at about the **same distance** from CERN (**130-135 Km**)





**Present road Tunnel at Fréjus (grey)
and
future Tunnel (black) for safety with 34 bypasses (shelters)
connecting the two Tunnels**



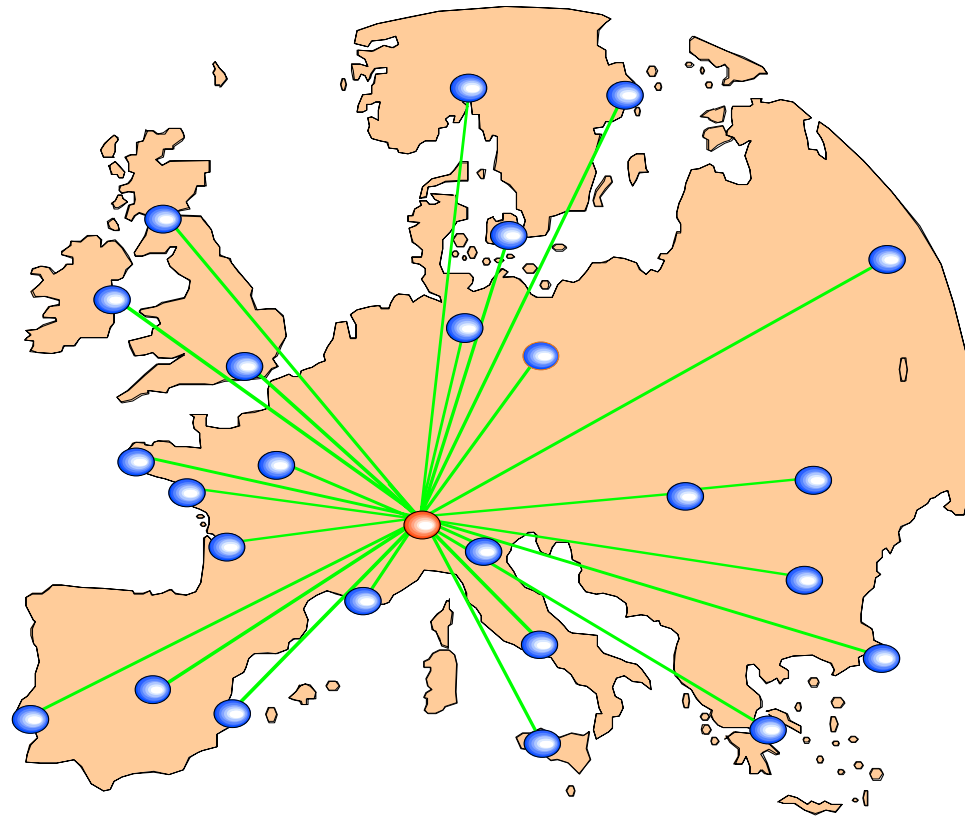
The Fréjus site (green) is at the junction between the Regions of
RHÔNE-ALPES (FRANCE)
and
PIEMONTE (ITALY)

26/09/2004

11



20/09/2004



Position o f the F réjus site in Europe

A very massive Detector

-Water Cerenkov : 1 Megaton of UNO or HyperK type
“**MEMPHYS**” project (**ME**gaton **MA**ss **PHYS**ics)

and/or :

-Liquid Argon : 100 Ktons (“**Glacier**” Expt.)
**A. Ereditato & A. Rubbia, “Physics with a Multi-MW
Proton Source”(CERN Workshop, 25-27 May 2004)**

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R&D for Cherenkov Detectors

PMT's : cooperation with PHOTONIS (and HAMAMATSU ?)

- increase of the light collection efficiency
- reliability improvement
- decrease of the cost

(HPD (APD), Flat Panel PMT, etc)

Gadolinium (GdCl_3) doping of the water to strongly improve
(Relic) Supernovae Neutrinos detection (neutron capture)
(John Beacom and Mark Vagins)

R&D for Liquid Argon Detector

-> see André Rubbia's talk of yesterday

Letter of Intent for the VILLARS 2004 SPSC workshop

**Discovery potential for a SPL/super beam and beta beam from CERN pointing
at a Megaton class detector in the Fréjus area**

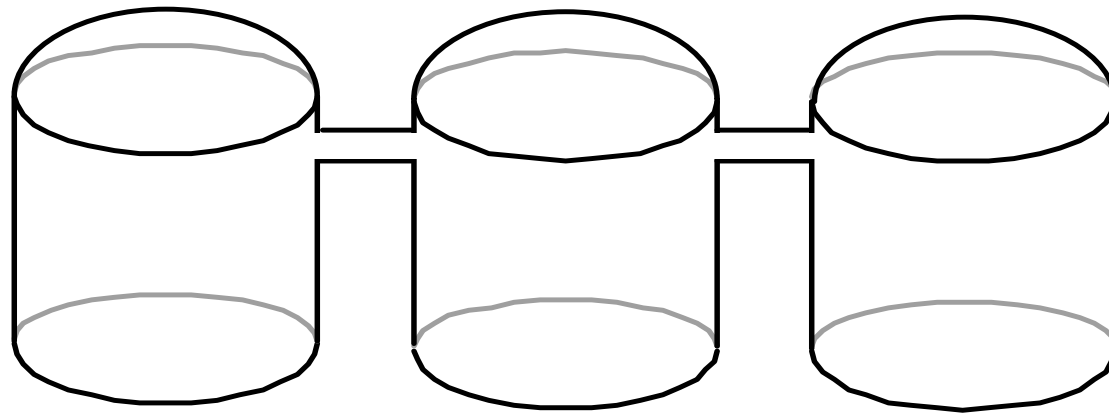
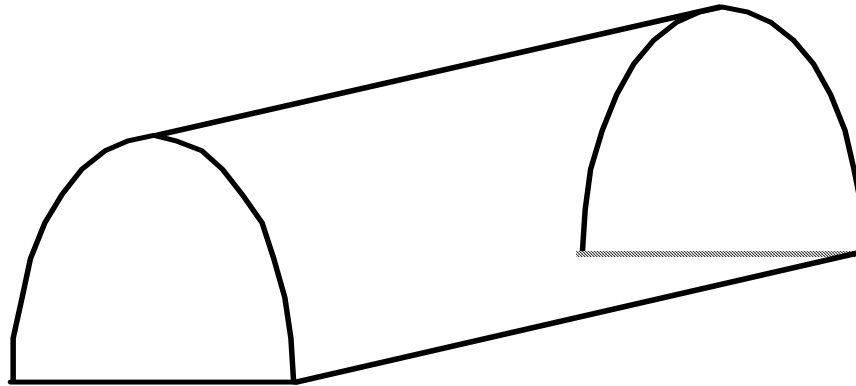
A. Blondel, GENEVA UNIV., J. Bouchez, C. Cavata, L. Mosca, DAPNIA/CEA, A. de Bellefon,
D. Boutigny, JE. Campagne, J. Dumarchez, M. Dracos, D. Duchesneau, J. Favier, S. Katsanevas, H.
Pessard, IN2P3/CNRS, M. Mezzetto, V. Palladino INFN

**Preliminary study
for a very large cavity ($- 10^6 \text{ m}^3$)
at Fréjus**

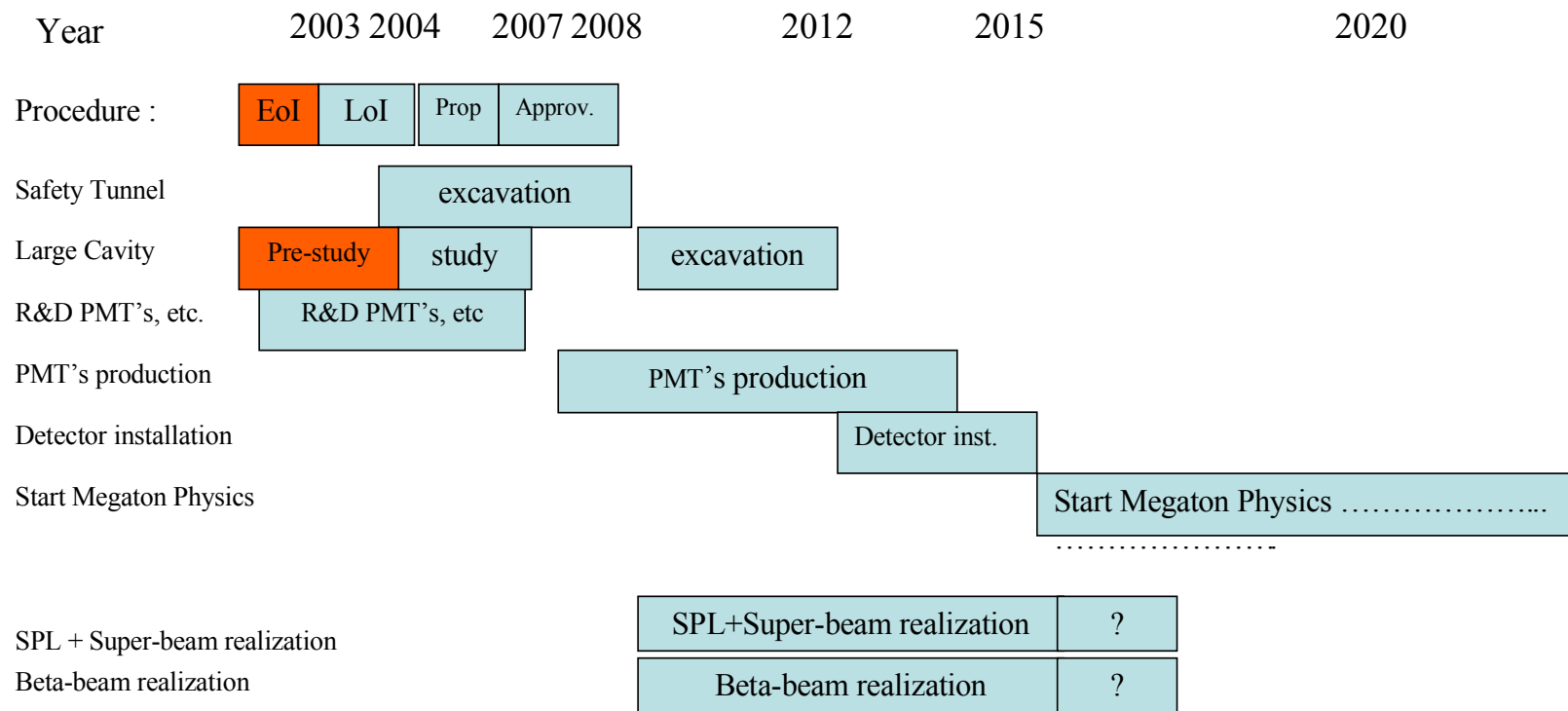
Objectives :

- 1) Feasibility -> determine the **maximum possible size** of the cavity for each type of considered geometry (see the next transparency)
 - 2) Estimate (roughly) the **cost** and the **time** of the excavation
- > Then a more detailed and extensive study (**design study**) will be performed with (hopefully) a contribution from the European Community (EC)

**Two types of geometry that will be considered
in the preliminary study for the future Lab.**



An « Optimal » schedule for a Megaton Physics Project in Europe



To summarize

- The “seven virtues” of the Fréjus site :

- 1) **great depth** (4 800 mwe)
- 2) good quality of the rock
- 3) independent horizontal access
- 4) central geographical position in Europe
- 5) “**magic distance**” from CERN (130 km) :
Neutrino Super-beams and Betabeams
- 6) strong support from the local authorities
- 7) strategical position at the Italian/French border

Conclusions and outlook

- The **Fréjus site** is well adapted for a Megaton Cerenkov and/or Liquid-Argon Detectors Facility both for “non accelerator” and “accelerator” Physics
- This **International facility** will open the possibility of realizing a very wide and challenging physical program including several “**golden experiments**”
- A **feasibility study** of this very large laboratory is now necessary and will be performed in the next future
- In the frame of an “**optimal schedule**”, the “**non accelerator**” sector of the Physics Program **can start as soon as the laboratory and the detector are ready (2012 -2014?)**, while the “**accelerator**” sector can join the game later, as soon as the **neutrino beam(s)** will be completed (**2015-2017 ?**)
- You are all warmly invited to the **NNN05 Workshop**, which will take place at **AUSSOIS** (a very nice village near the Fréjus site) from **7th to 9th April 2005**

**Next Generation Nucleon Decay and Neutrino Detector:
Nnn99 Stony Brook, New York 23-25 September 1999
(Aip Conference Proceedings, 533)**