

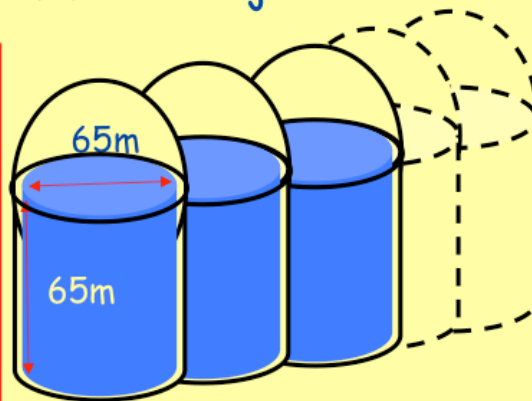
# MEgaton Mass PHYSics Project

- Physics Motivations
- The Installation
  - a Very Large Laboratory
  - a MegaTon scale Detector
  - the Neutrino Beams
- Expected physics potential
- Tentative schedule

## The MEMPHYS Project



4800mwe



Water Cerenkov modules at Fréjus

CERN to Fréjus

Neutrino Super-beam and Beta-beam

Excavation engineering pre-study has been done for 5 shafts

## Physics Motivations

- Nucleon Decay
- Super Novae Neutrinos:  
burst & relic
- Solar & Atmospheric Neutrinos
- Neutrinos from Accelerators  
Super Beam, Beta Beam
- And also:
  - Dark Matter (WIMP) indirect detection, High energy neutrinos,...

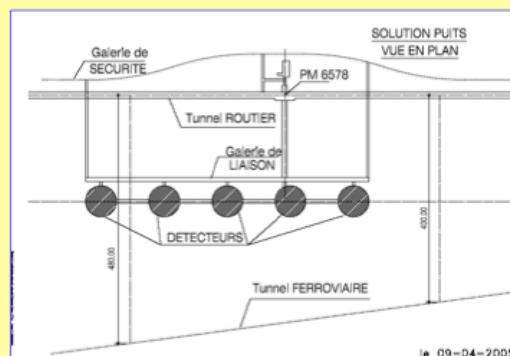
## A Very Large Laboratory

In the middle of the Fréjus tunnel at a depth 4800 m.w.e (where the quality of the rock is the best !)

a preliminary investigation shows the feasibility of excavating up to five shafts of about 250,000 m<sup>3</sup> each

Estimated cost :

≈ 80 M€ x Nb of shafts



## A MegaTon scale Detector

3 to 4 Water Cerenkov modules (20 x Super K  
 $\approx$  500kT fiducial mass) equipped with a large  
number of Photodetectors (eg. 250,000 PMTs 12")

a very well proved and robust technique which  
provided already remarkable physical results  
mainly in Nucleon Decay and Neutrino Physics and  
Astrophysics

## Very intense 300÷400 MeV Neutrino Beams from CERN

Super Beam based on a 4MW Proton Driver  
(eg. SPL) :

$\nu_{\mu}$  and  $\bar{\nu}_{\mu}$  from pion decay

Beta Beam (possibly in connection with the  
EURISOL project) :

$\nu_e$  and  $\bar{\nu}_e$  from heavy ions decay

# Specific Physics potential

## A) non accelerator physics

### Nucleon decay

- up to  $\sim 10^{35}$  yrs ( $p \rightarrow e^+ \pi^0$ )
- few  $10^{34}$  yrs ( $p \rightarrow \bar{\nu} K^+$ ) with a detection threshold below 6MeV

### Neutrino burst from Super-Novae explosion

- 150,000 events from SN at 10kpc
- 50 events from Andromeda

### Relic Neutrinos from past Super-Novae explosions

- 250 events/10y/0.5Mt (with pure water)
- 2500 events/10y/0.5Mt (with Gd loaded water)

# Specific Physics potential

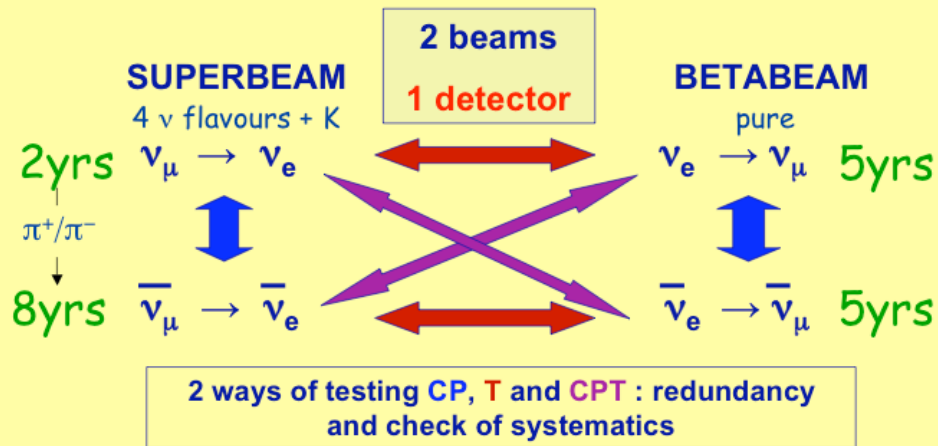
## B) accelerator physics

### PMNS matrix parameters measurement :

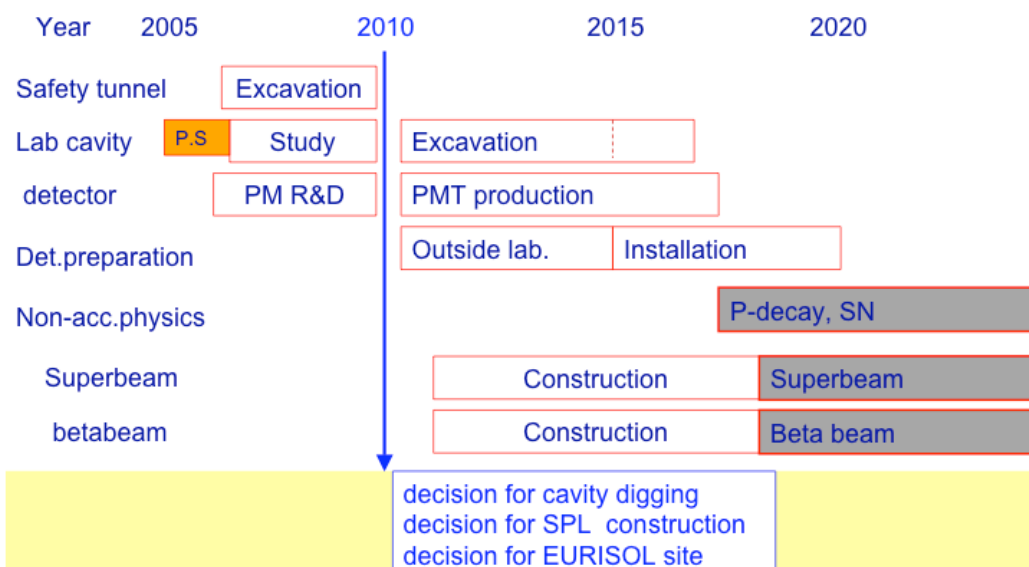
->  $\theta_{13} < 0.7^\circ$  @90%CL ( $\nu_\mu$  beam 2.5Mt.y)

-> for  $40^\circ < |\delta_{CP}| < 140^\circ$  : CP violation discovery @ $3\sigma$   
( at  $\theta_{13} = 1^\circ$  and 10yrs of Beta Beam and Super Beam )

## Superbeam + beta beam together



## A possible schedule for a European Lab. at Frejus



## Specific **requests** from the **MEMPHYS** Group to the European **FP7** Network

### **A) Networking activities** concerning :

- A1) the **Physics potential** of Large Deep Underground Experiments in both non- accelerator and accelerator sectors
- A2) the **Underground Laboratories** for “**Mega**” detectors :  
**best strategies** for excavation, access and **equipments** (ventilation, air-conditioning, power supply, etc.)
- A3) the **Safety optimisation** in Very Large Underground Facilities

### **B) Joint research activities :**

- B1) Development of **cheap photo-detectors**, optimized for covering **large areas** and suitable to detect Cerenkov light (visible + UV ?) with high efficiency :
  - a) **vacuum photo-tubes**
    - “standard” (with dynodes) PMTs
    - “hybrid” (with PIN or APD diodes) HPD
    - “smart” PMTs (?)
    - “wall papers” (“à la Ferenc”) (??)
  - b) **gaseous photo-tubes**, “wall paper” shaped :
    - with CsI photo-cathode (Ultra-Violet region)
    - with bi-alkali photo-cathode (visible region)

### B2) Associated “**compact**” **power supply** and **electronics**

### C) Design Studies concerning :

the excavation of **3 to 5 “shafts”** of about **250000 m3 each** in the central region of the Fréjus Tunnel, the **associated equipments** and the **mechanics of the detector** modules :

- a) precise “in situ” investigation of the rock quality parameters
- b) optimisation of the shafts shape
- c) optimisation (choice) of the type of local access
- d) definition of the required equipments : ventilation and air-conditioning, water purification “factory”, electric power supply, etc.
- e) define the best solution for the water containment and for the photo-detectors support

## Financial contributions asked to FP7

(as considered from the MEMPHYS project point of view)

≈ **100 K€** for the **Networking Activities**

≈ **350 K€** for the **Joint Research Activities**

(R&D for Photodetectors and electronics)

(total cost ≈ 2 M€)

≈ **5 M€** for the **Design Study** of the Laboratory

(and the mechanics of the detector)

(total cost ≈ 25 M€)