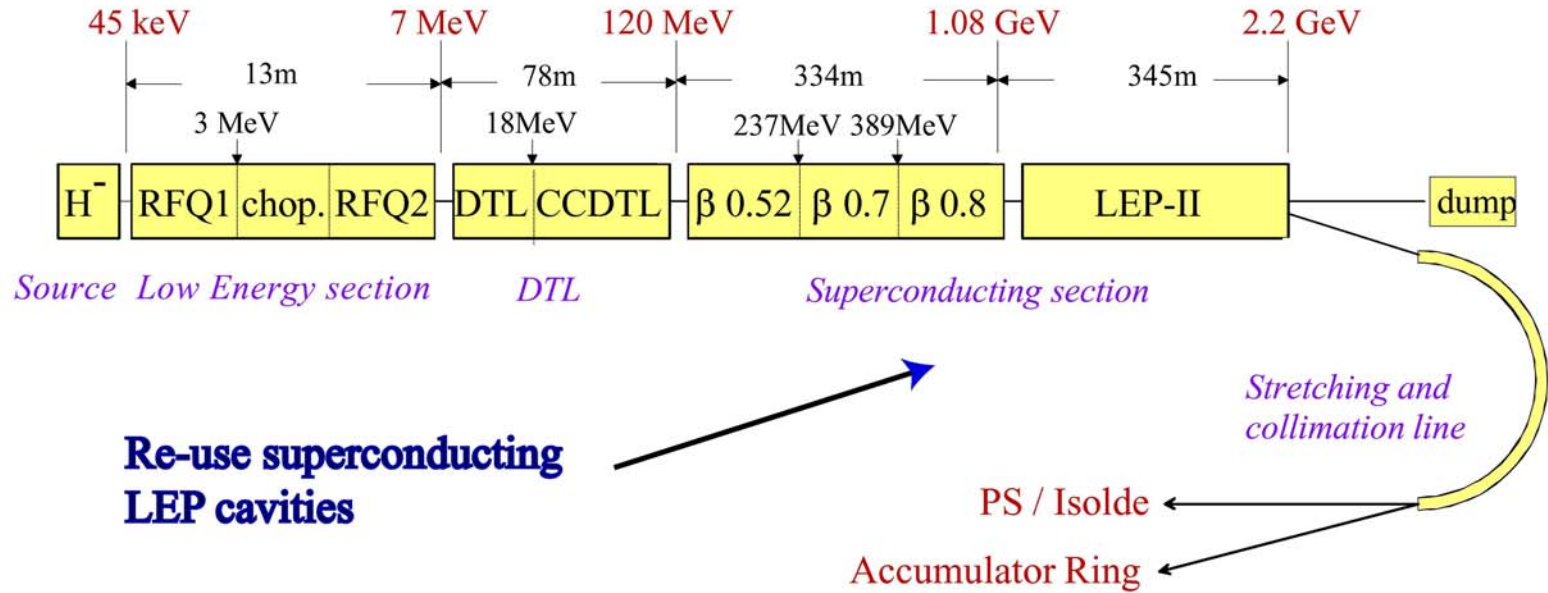


**A new underground laboratory at Frejus**

- **Historical overview**
- **Latest developments**
- **Outlook**

# PROTON DRIVER FOR CERN NEUTRINO FACTORY

## MW-Linac: SPL (Superconducting Proton Linac)



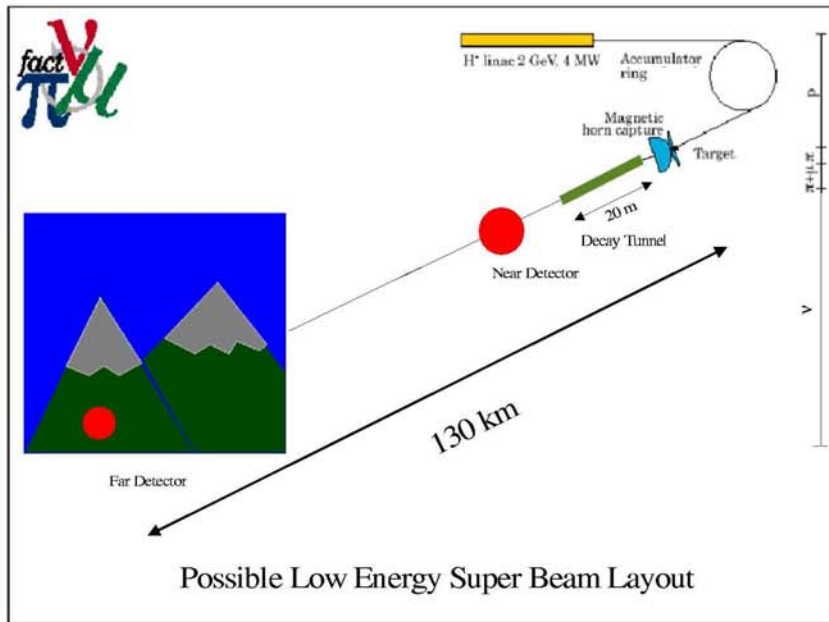
**$E_{KIN} = 2.2 \text{ GeV}$**   
**Power = 4 MW**  
**Protons/s =  $10^{16}$**



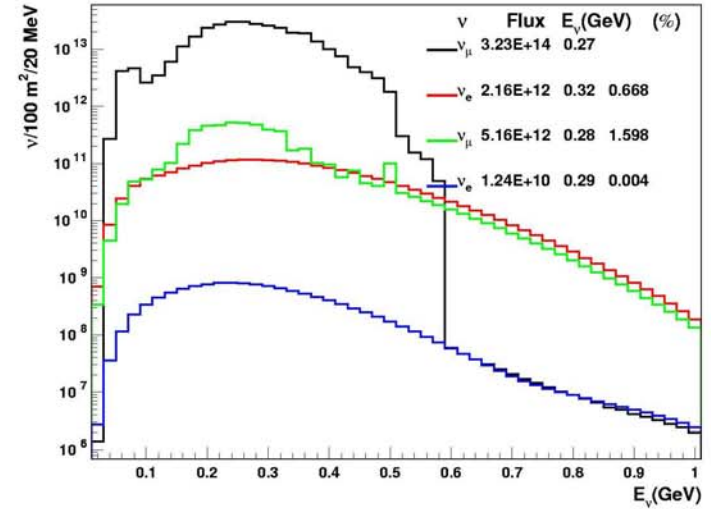
**$23$**   
 **$10^{23}$  protons/year**

# SPL-SuperBeam at CERN

A feasibility study of the CERN possible developments

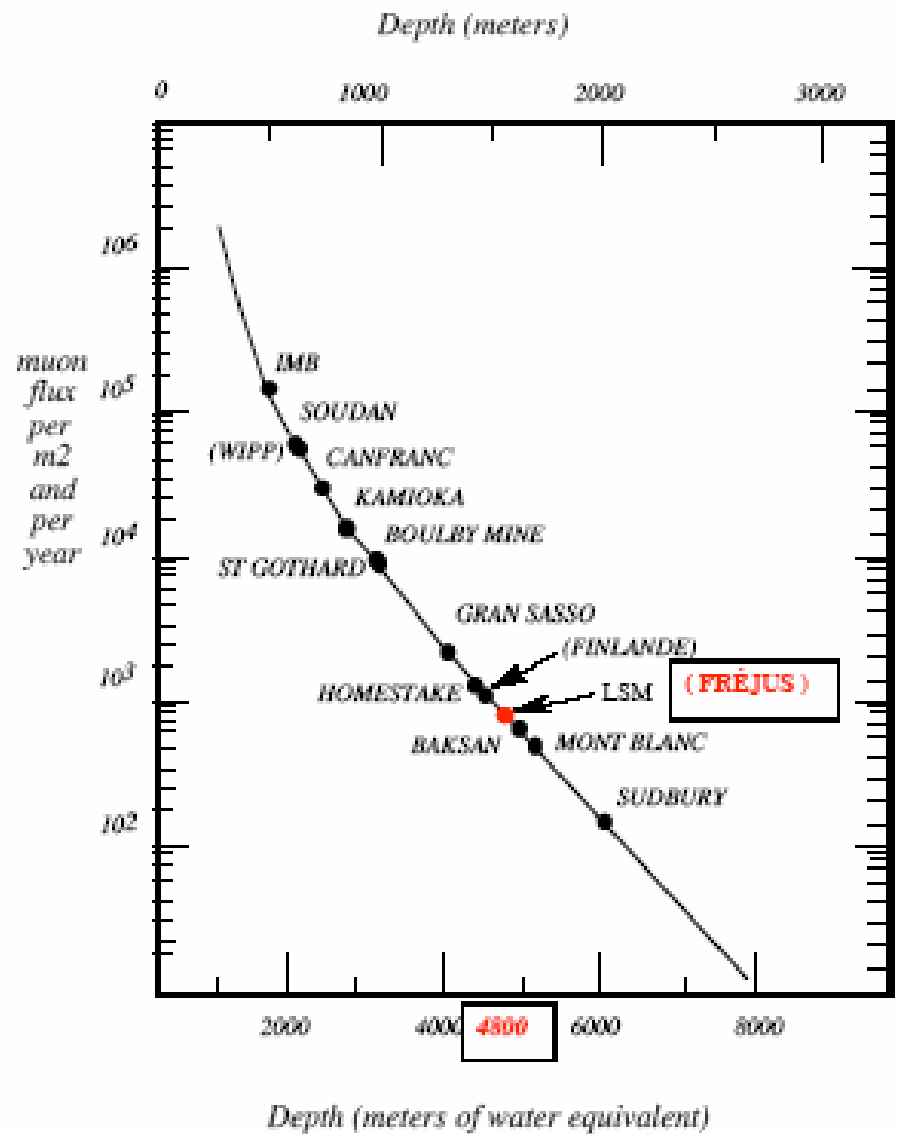


**Frejus lab is 130 km away from CERN !**

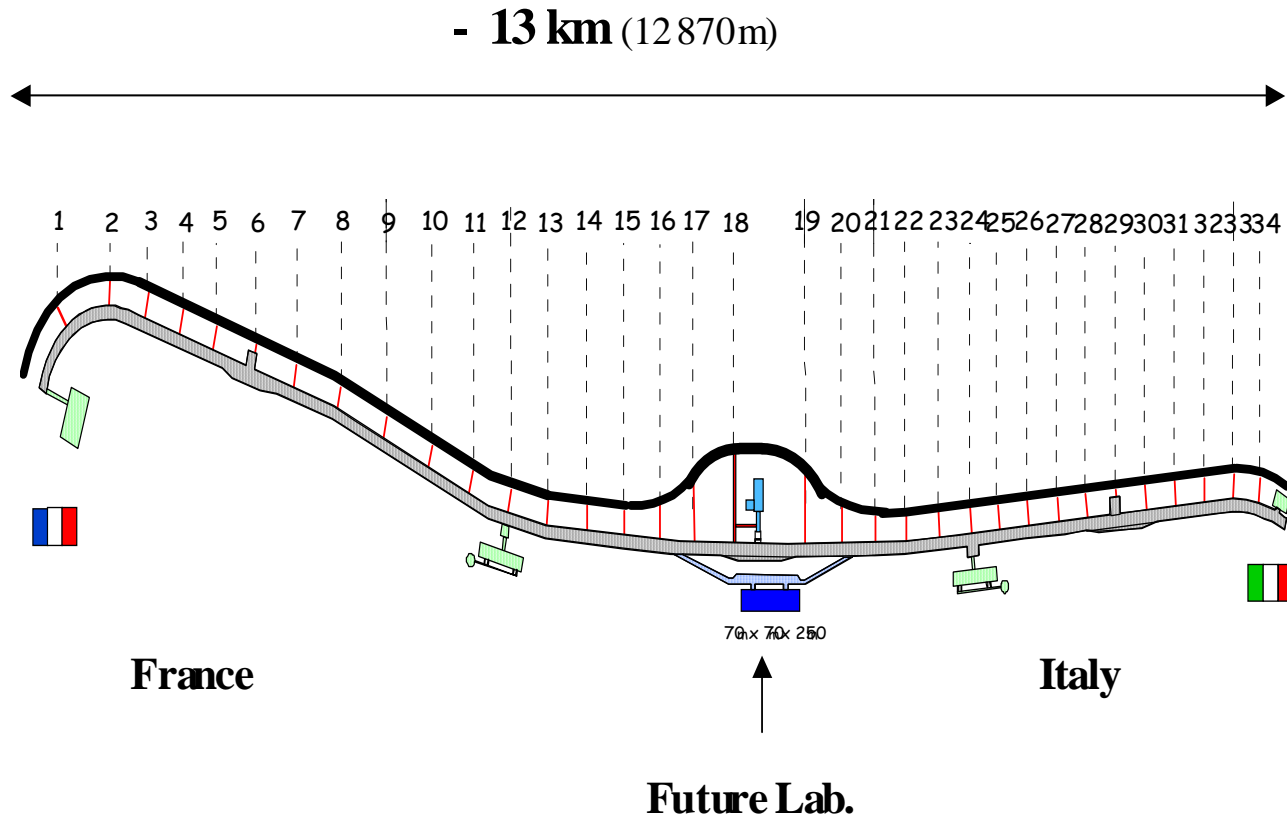


Flux intensities at 50 km from the target

Flavour	Absolute Flux ( $\nu/10^{23}$ pot/m <sup>2</sup> )	Rel. Flux (%)	$\langle E_\nu \rangle$ (GeV)
$\nu_\mu$	$3.2 \cdot 10^{12}$	100	0.27
$\bar{\nu}_\mu$	$2.2 \cdot 10^{10}$	1.6	0.28
$\nu_e$	$5.2 \cdot 10^9$	0.67	0.32
$\bar{\nu}_e$	$1.2 \cdot 10^8$	0.004	0.29



# A SAFETY GALLERY TO BE BUILT ALONG THE EXISTING TUNNEL



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

## PROPOSAL FOR A NEW UNDERGROUND LAB AT FREJUS

- Excavation of safety gallery completed around 2009 when machines meet at the center.
- **Excellent opportunity** to dig a new cavity at reduced cost in the middle of the tunnel, which could be ready by 2012 and house a detector for the neutrino superbeam
- Horizontal access, rock quality known and good (and no water!)
- Schedule of such a detector comes **much after** T2K phase 1 and NuMI off-axis (now NOVA). So, **directly propose** a detector able to see **CP violation** => **Megaton Cerenkov detector** (or liquid Ar)
- First studies based on a UNO-like detector show excellent sensitivity to  $\theta_{13}$  and  $\delta_{CP}$ , similar to T2K phase 2 (4 MW + HK)
- Project favourably considered by our scientific authorities, with a strong support from local authorities

## MORE RECENT DEVELOPMENTS

- **A new idea** (P.Zucchelli): Beta beams, produced by radioactive ions stored in a decay ring, give a novel way to produce  $\nu_e$  and anti- $\nu_e$  beams of very high purity, perfectly known spectrum and intensity. **The required ion energy is achievable with the SPS !** (see M.Lindroos'talk tomorrow)
- The **combination** of beta beams and superbeams gives **unique redundancy** (CP,T,CPT in different ways), and a direct handle on how the detector sees the signal in each beam (as it is the bulk of events seen with the other beam)
- The superbeam has been further **optimized** (higher energy, higher intensity)
- **see M.Mezzetto's talk tomorrow on the remarkable performances of Beta beams + superbeams.**
- Beta beams profit from a strong synergy with nuclear physicists using radioactive ions produced by the ISOL technique: **Neutrino beta beams are now part of the design study funded by Europe on the EURISOL facility.**

$\Theta_{13}$   
degrees

EXCLUDED BY CHOOZ

9

Minos, Icarus, Opera  
Double Chooz

5

T2K1, NovA

1

SB

T2K 2

$\beta$  B

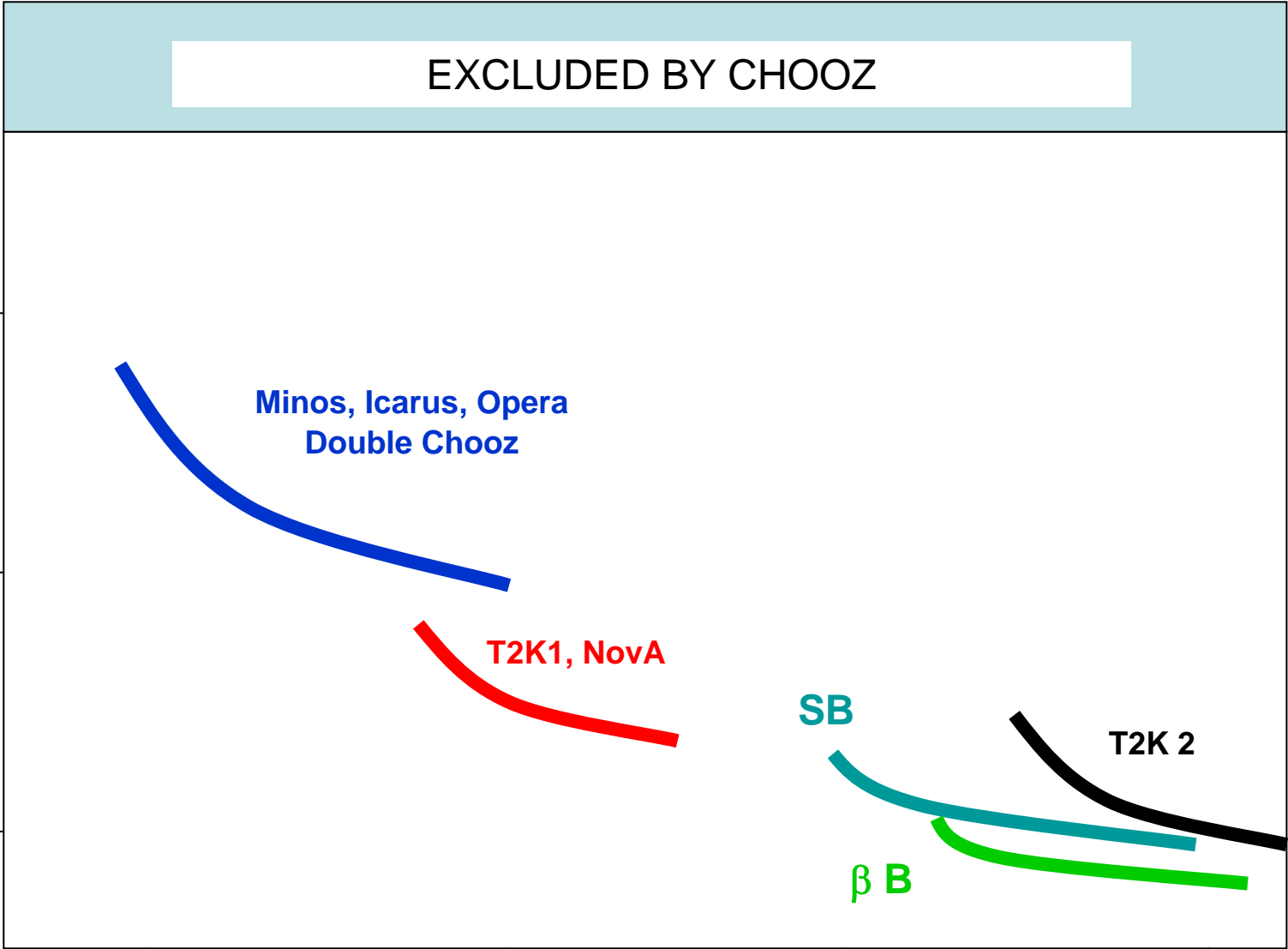
06

12

YEAR

18

24





## SCHEDULE

Super and beta beams will hopefully be ready before 2020....

....**BUT**

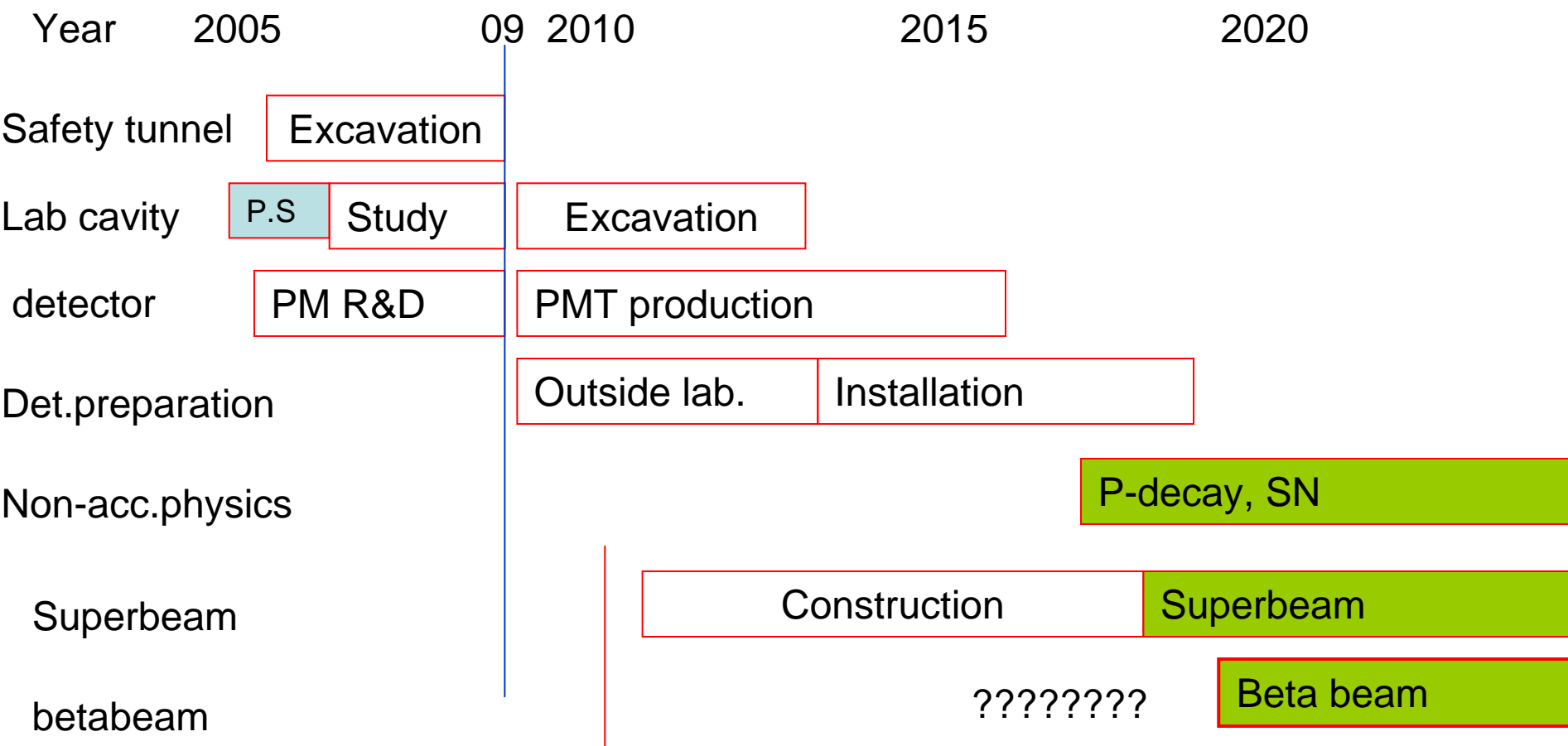
**We do not have to wait for them to build a detector**, as non-accelerator physics is at least as rich as neutrino beam physics:

- proton decay, with some chance of discovery
- SN explosion ( for SN mechanism AND neutrino oscillations)

**So, our preferred strategy is:**

1. Build a cavity and a detector, taking benefit of the safety gallery
2. Start non-accelerator physics right away
3. Begin neutrino oscillation study as soon as beams are available

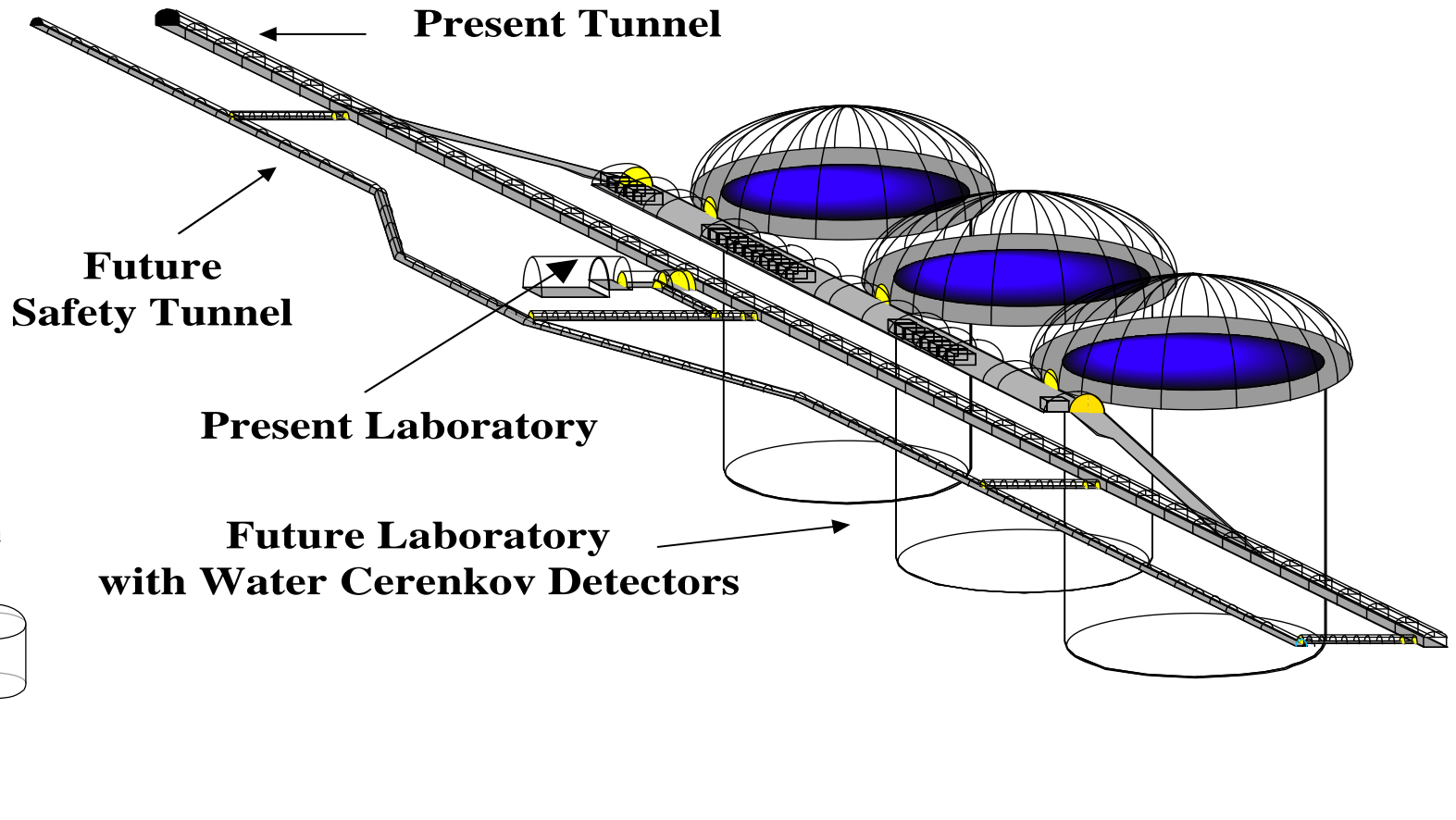
A possibly optimistic schedule for a european lab. at Frejus



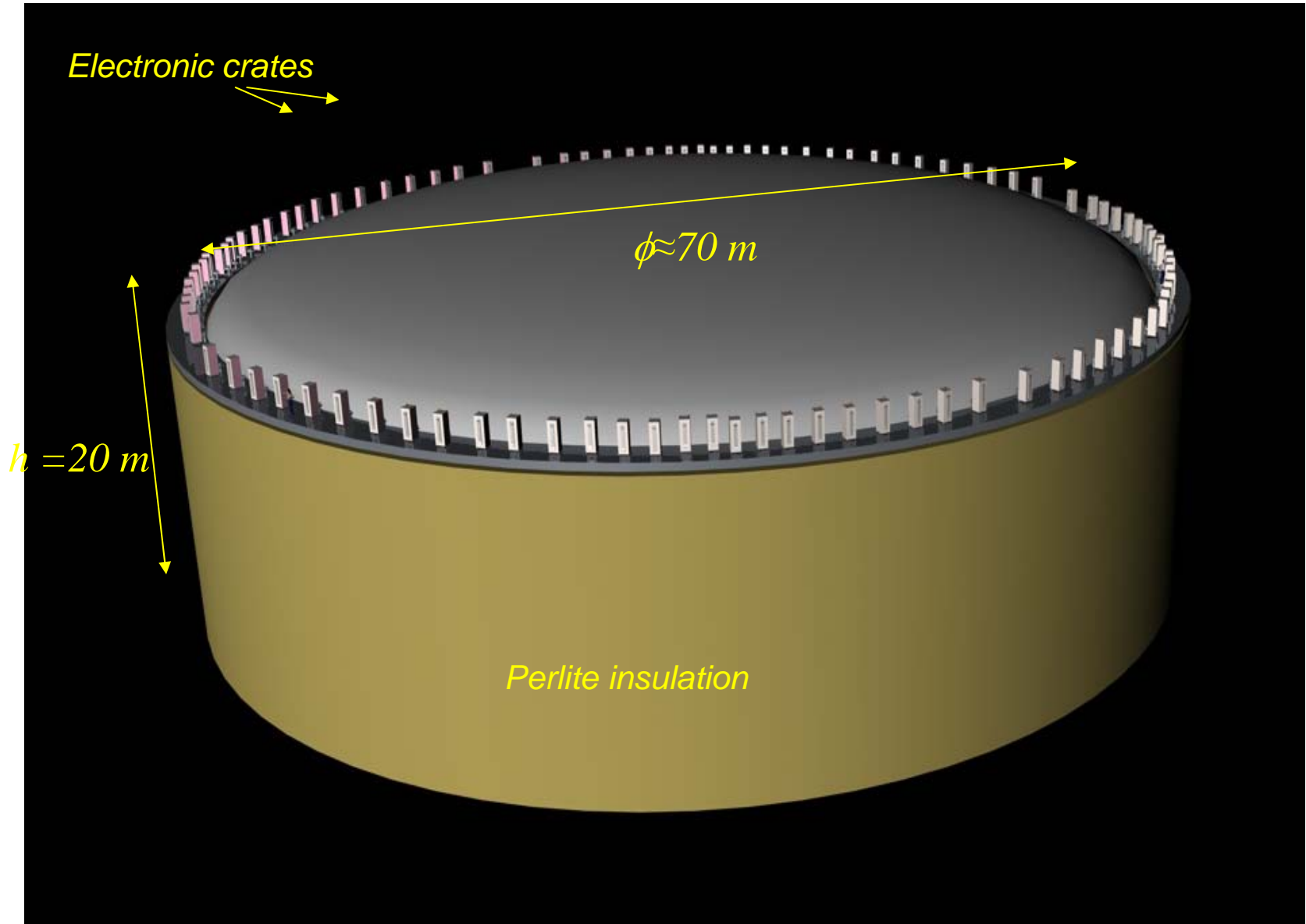
Several modules: physics can start when the 1<sup>st</sup> is ready

# Components of the Project

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



# 100 kt liquid argon (see A. Rubbia's talk)



# FROM DREAM TO REALITY

1. A **prestudy** on the feasibility of the cavity has been launched:

It will address maximal dimensions, preferred topology, cost... (both for Cerenkov and LAr): **first results (very preliminary) will be presented by M.Levy on Saturday morning**

2. Funding for a more detailed study will be requested to Europe in 2007 (next call)
3. R&D on photodetection is mandatory, **a collaboration with Photonis has started**. Other ideas on low cost large area photodetection (micromegas) are also considered.
4. **We are looking forward to a closer inter-regional (north-America, Japan, Europe) cooperation, demonstrating a strong and converging interest on this very fundamental and promising field of physics**

The end ...  
of the prologue