

Deliverable 4.1

Agnieszka Zalewska

CERN, 3.3.2011

Deep science paper for general public

Contents, title and style

- Focused on physics and astrophysics (less interdisciplinary approach than in the case of the paper written for DUSEL)
- Proposed title: „LAGUNA - Cosmos seen from underground“
- Main parts:
 - Introduction - LAGUNA - like a small EU, but open to global initiatives and collaborations
 - Enigmatic neutrinos
 - World of symmetries
 - Gigantic pots at the cutting edge of technology
 - Fundamental research in mines and road tunnels
 - In addition
- Style: informative , but „light“, colour frames with text plus graphics (like for leaflet)

Attractive title is important

**Oscylujące neutrino,
rozpadający się proton
oraz
zagadka Ciemnej Materii**

D. Stefan, A. Szec, T. Wachała

**Dzień otwarty IFJ PAN,
26.09.2008**



LAGUNA as a Pan-European project (introduction)



SITE STUDY

Candidate Sites

- Boulby, UK
- Canfranc, Spain
- Fréjus, France
- Pyhäsalmi, Finland
- Sieroszowice, Poland
- Slanic, Romania

Casco, Italy

Collaboration

100 scientists
more than 20 institutes
11 European countries

1 page

Enigmatic neutrinos

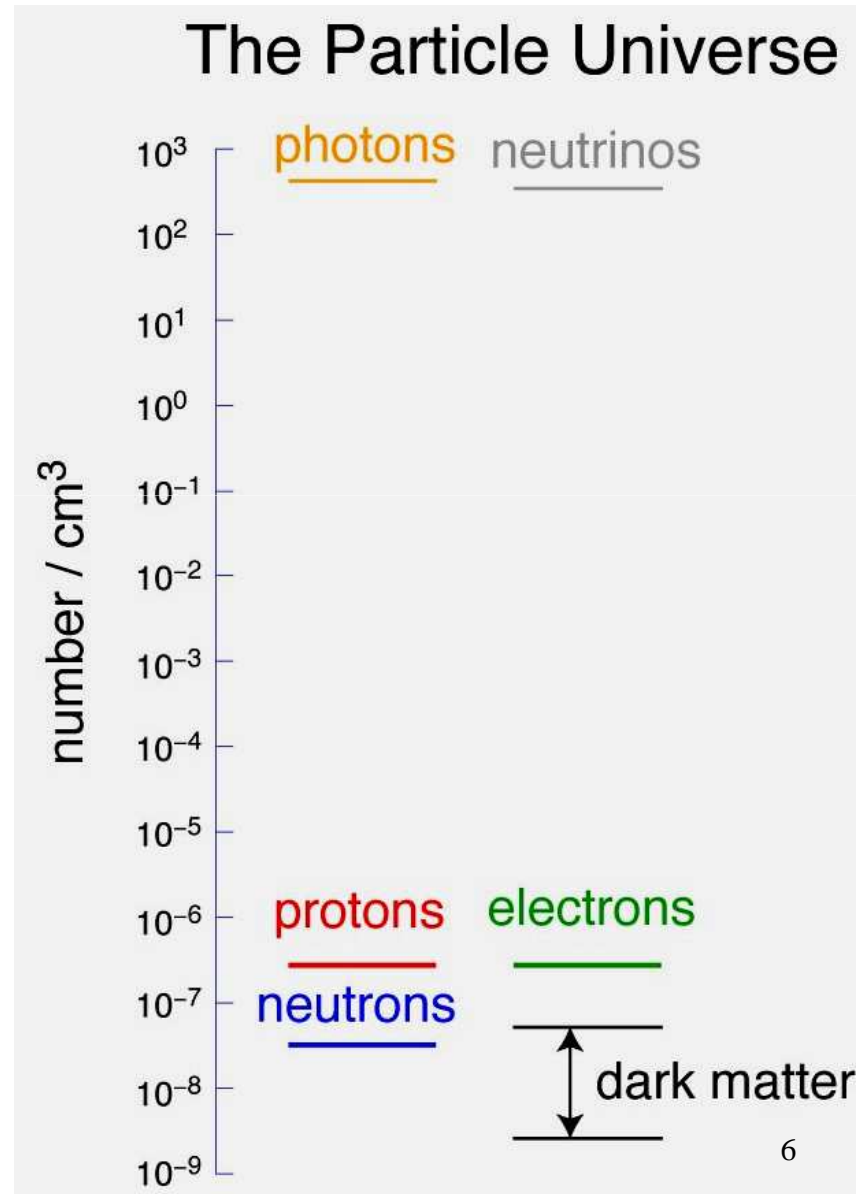
- Omnipresent
- BUT interacting only weakly
- Slightly undefined (oscillations)
- Astrophysical messengers:
 - from early Universe
 - from very long distances
 - from star lives and deaths
- Geoneutrinos - messengers from inside the Earth
- Dark matter - are WIMP's hidden in the centres of Earth, Sun and our Galaxy?

5 pages

Neutrinos are omnipresent

Neutrinos are the second most abundant particles in the Universe, e.g.

- There are about 300 relict neutrinos in each cm^3 of the Universe
- A typical power station produces 6×10^{20} neutrinos/s
- Each of us contains about 20 mg of ^{40}K \rightarrow emits 300 millions of neutrinos/day



Neutrino sources

Types of neutrinos observed in experiments:

Natural: solar, atmospheric, from Supernova explosions and other astrophysical sources, geo-neutrinos

Artificial: reactor and accelerator neutrinos

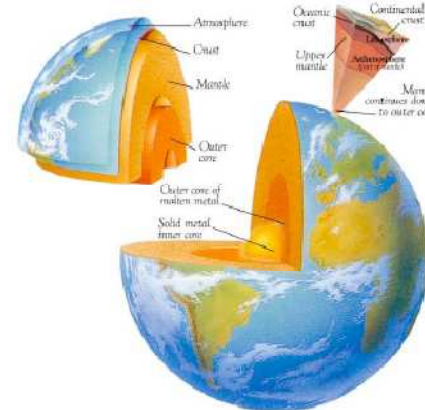
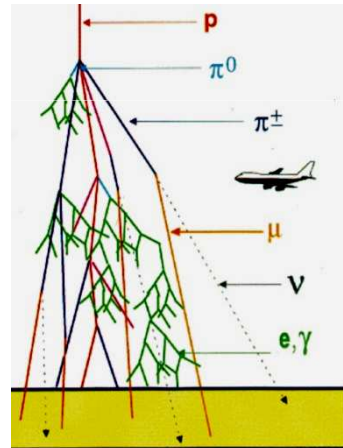
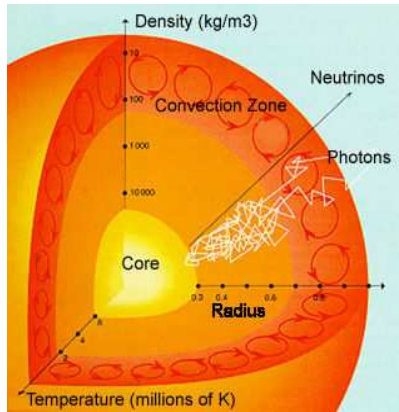
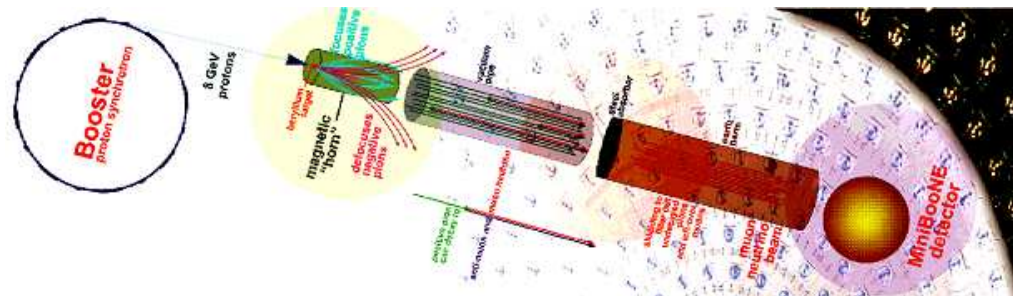
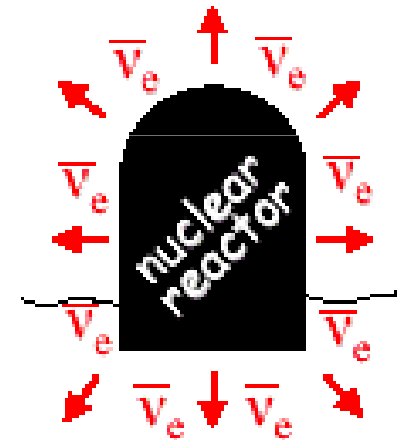
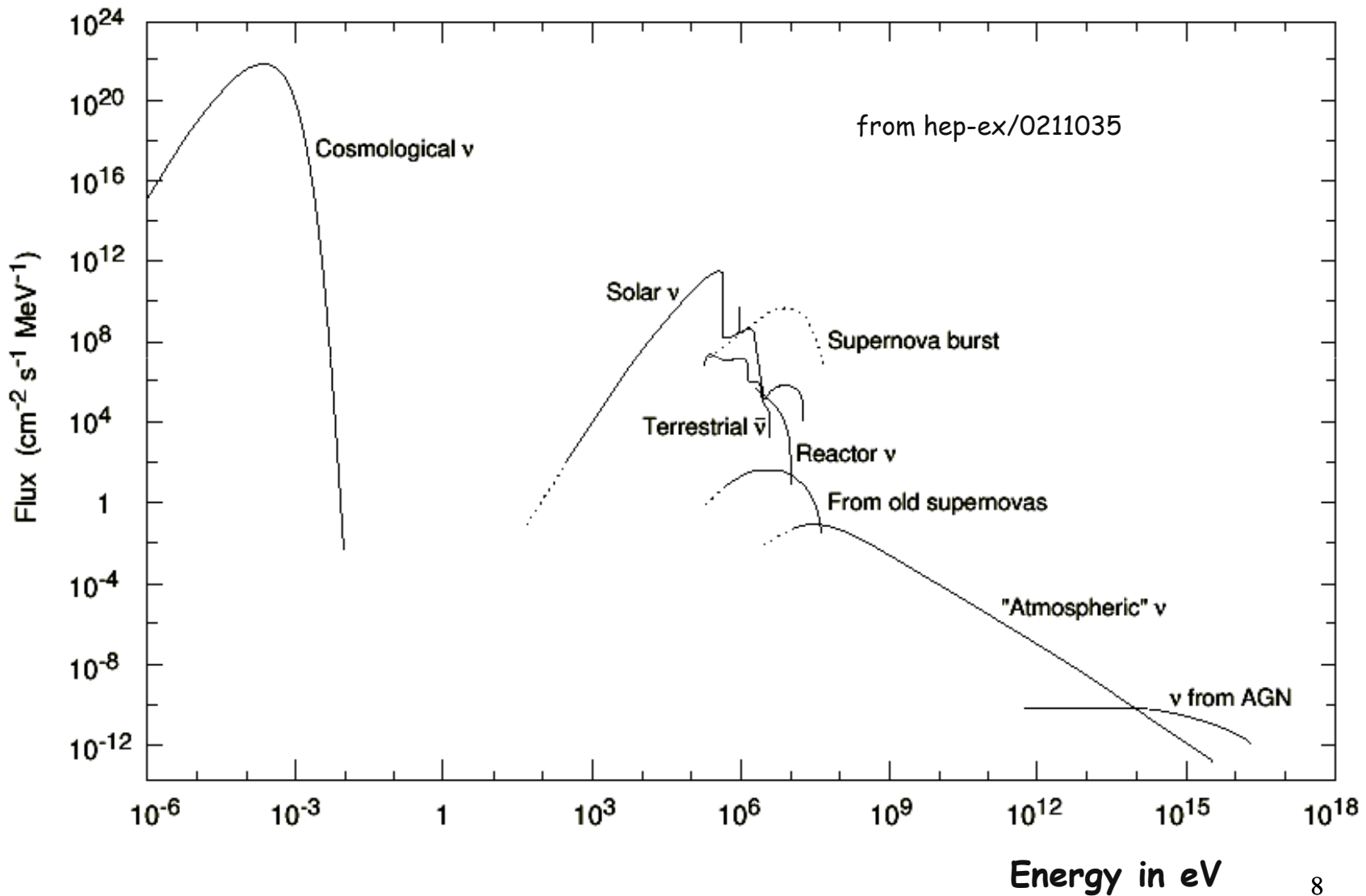


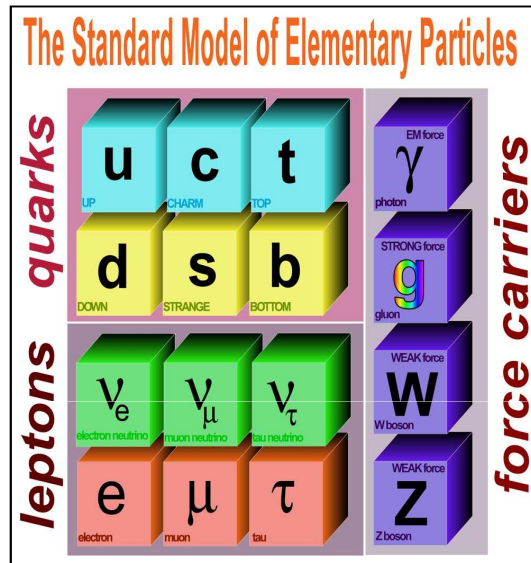
Image by Colin Rose and Dorling Kindersley



Neutrino fluxes and energies

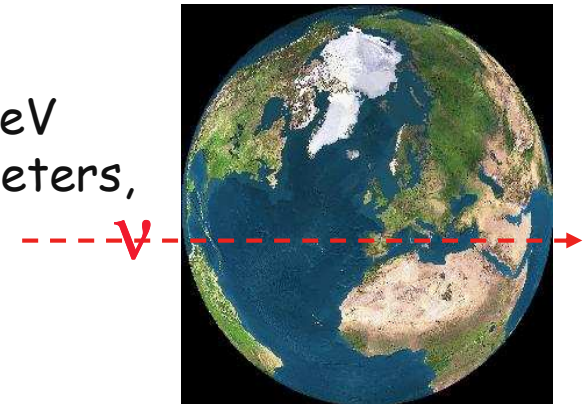


BUT interact very weakly



Neutrinos are neutral leptons

-they interact only weakly, so e.g. a mean free path for neutrino of energy 1 GeV in Earth is 10^6 Earth diameters, thus 10^6 such neutrinos are needed to get one interacting in the Earth

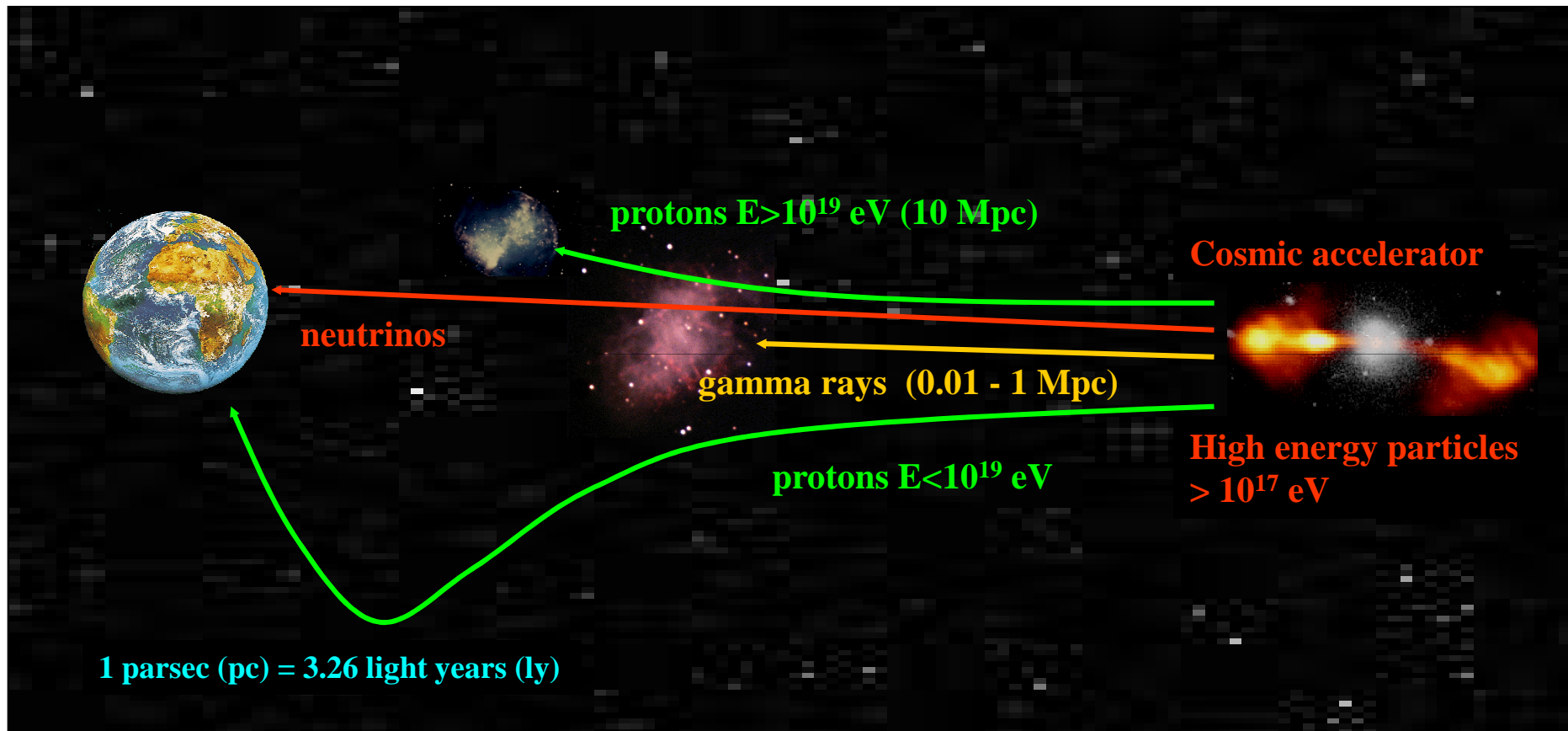


As another example, the mean free path of the solar neutrinos in our galaxy is of the order of the galaxy diameter

→ implies bright prospects for neutrino astronomy

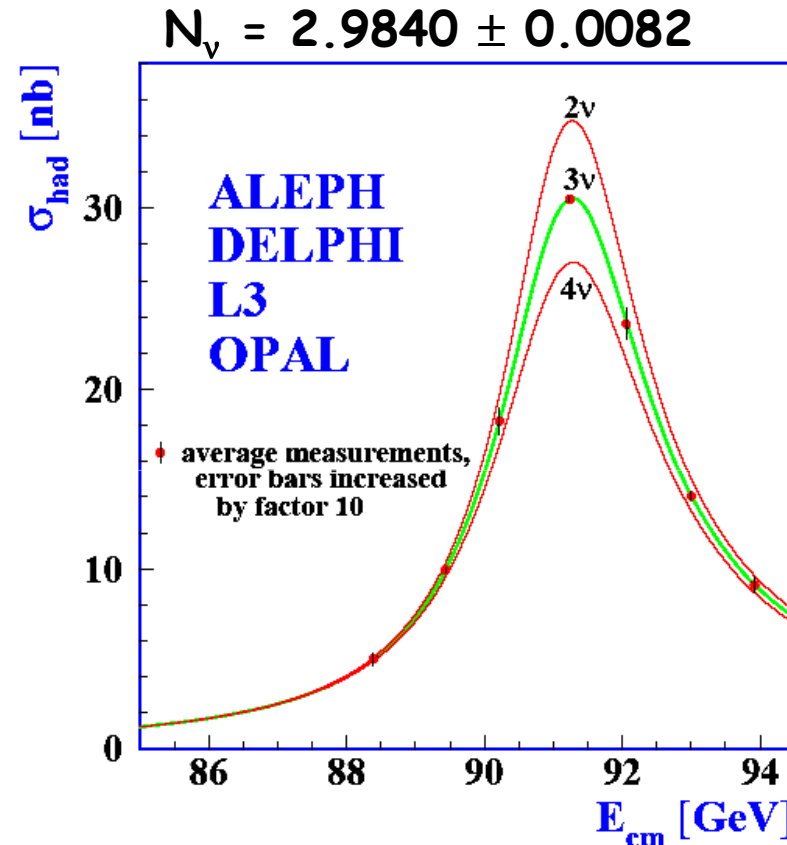
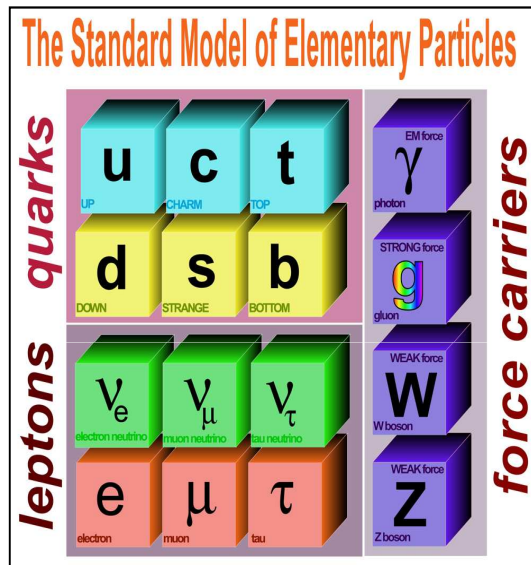
As another example - number of interactions during an average human life

Messengers from long distances



P.Piatelli, Paris, 2004

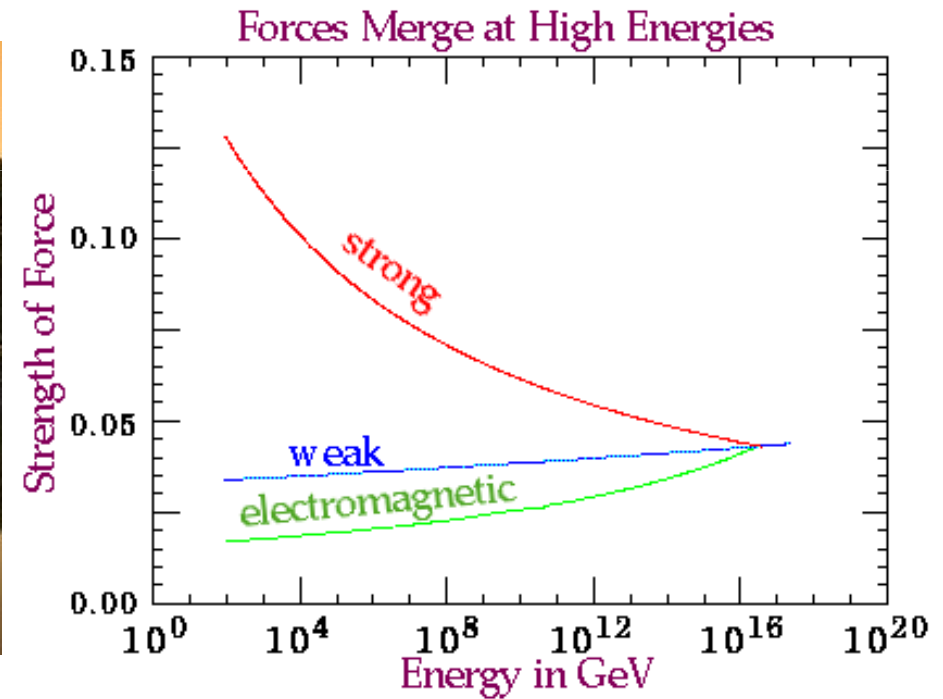
Three neutrino flavours - three families



LEP result - just three active (coupling to Z^0) and light (with a mass smaller than $Z^0/2$) neutrinos with different flavours: ν_e ν_μ ν_τ
 if more neutrinos are found, the other ones have to be of a different type (sterile neutrinos)

World of symmetries

- Proton decay
- CP violation for neutrinos



2 pages

Gigantic pots at the cutting edge of technology

- REALLY big (pictures with known buildings inside)
- Challenging constructions (tanks)
- More light, please (photodetectors)
- Underground caverns, please (yes - it is possible - geomechanics)

4 pages

The LAGUNA detectors:

100 ktons of liquid argon

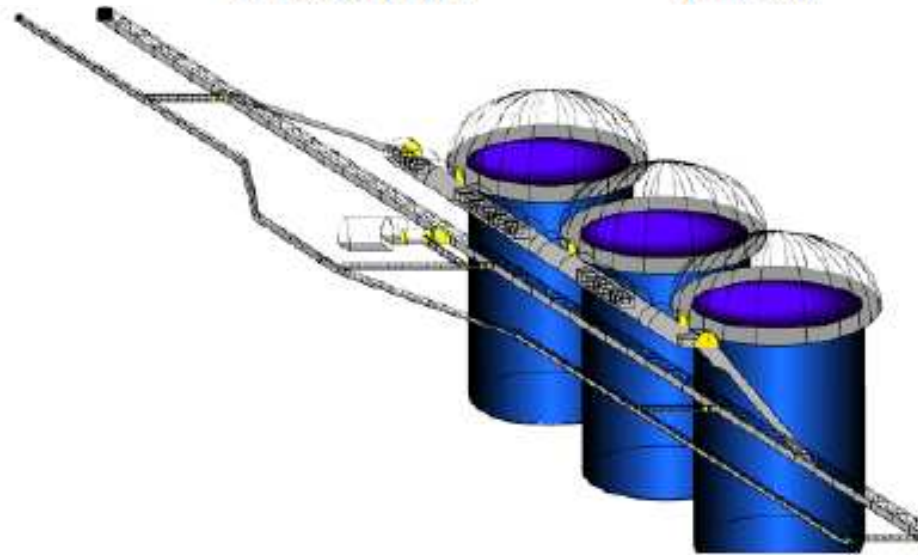


GLACIER



50 ktons of liquid scintillator

LENA



~500 ktons of water

MEMPHYS

Fundamental research in mines and road tunnels

- LAGUNA - overview of geology and of other „features“ (e.g. seismic behaviour) of Europe
- Overview of sites
 - Let us go to the polar circle
 - The oldest tunnel in Alpes serves science
 - Green, sunny fields in Umbria - why not?
 - In majestic Pyrenees
 - Under land and sea
 - Cathedrals in salt
 - Science hosted by the European copper giant

8 pages ?

In addition

- What happens outside Europe?
- Neutrino physics with accelerator beams → LAGUNA/LBNO

2 pages

Summary

- 22 pages plus 4 cover pages

- Schedule - tight

- March - building up the structure - work on graphics (Robert Sulej)
 - photos from Wladek very welcome

- March - May - writing texts (help is needed!)

- scientific paper of Sivia helpful for physics part

- contact persons for detectors (LENA - M.Wurm,
GLACIER - F.Petrolo, MEMPHYS - T.Patzak)

- contact persons for sites (Boulby-N.Spooner, Canfranc-

- L.Labarga, Frejus-Luigi/Thomas, Pyhäsalmi-W.Trzaska,

- Slanic-R. Margineanu, SUNLAB-me, Umbria - M.Messina)

- phone conference in the last week of March and then every two weeks -
Arnaud Marsollier consulted and invited