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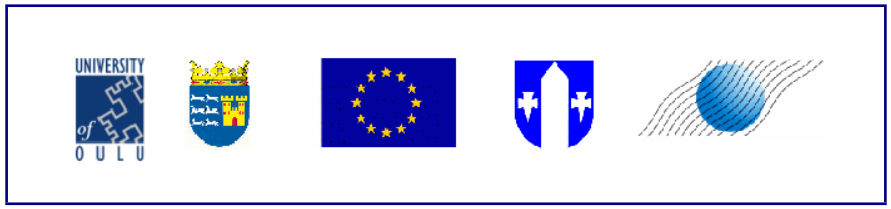
WP4: Background

What should be included in the Design Study for

- proton decay
- solar neutrinos
- supernova neutrinos (burst and relic)
- atmospheric neutrinos
- geo-neutrinos
- ...

in terms of background studies ?



Proton Decay [page 11 – 14]

- LENA
  - $p \longrightarrow K^+ \bar{\nu}$:
    - ☞ clear signature,
    - ☞ atmospheric ν background suppression of $\sim 2 \times 10^4$ (with PSA),
    - ☞ pion and kaon production background rate ~ 0.0064 year^{-1}
  - $p \longrightarrow e^+ \pi^0$:
    - ☞ atm ν background can be reduced (not yet simulated)
    - ☞ **To be determined in the Design Study**
- GLACIER
  - $p \longrightarrow K^+ \bar{\nu}$:
    - ☞ 1% mis-interpretation due to kaons, high selection efficiency

    $\Longrightarrow$ background less than 1 event Mt^{-1}year^{-1}
  - $p \longrightarrow e^+ \pi^0$:
    - ☞ background level of 1 Mt^{-1}year^{-1}
- MEMPHYS
  - $p \longrightarrow K^+ \bar{\nu}$:
  - $p \longrightarrow e^+ \pi^0$:

$\Longrightarrow$ **Conclusion: Mostly done (?)**

Solar Neutrinos [page 22 – 24]

(1) LENA

- ^{7}Be neutrinos: number of events $\sim 5 \times 10^{3}$ day^{-1}
  - ☞ depending on the background, could offer a sensitivity of 0.5 % to study the time variation of the flux in one month,
  - ☞ **To be determined in the Design Study**
- pep neutrinos: number of events ~ 210 day^{-1}
  - ☞ by elastic scattering, needs low background
  - ☞ **To be determined in the Design Study**
- ^{8}B neutrinos:
  - ☞ by cc with ^{13}C
  - ☞ some background estimations done, is it enough ?

Solar Neutrinos [page 22 – 24]

(2) GLACIER

- ES: $\nu_x + e^- \longrightarrow \nu_x + e^-$
  ABS: $\nu_e + {}^{40}Ar \longrightarrow e^- + {}^{40}K^* \longrightarrow {}^{40}K + \gamma$'s
  ☞ threshold set to ∼5 MeV to reject background from neutron capture followed by gamma-ray emission
  - neutrons induced by the spontaneous fission of the cavern rock
  - may be significantly recuded in a salt mine

  ☞ Event rate $\sim 33 \times 10^4$ year^{-1}
  (66% ABS, 25% ES, 9% neutron background)

☞ **To be determined in the Design Study (?)**

- lower threshold,
- other background sources,
- better neutron shielding,
- ...

Solar Neutrinos [page 22 – 24]

(3) MEMPHYS

Supernova Neutrinos [page 14 – 22]

burst and diffuse

- Burst
  - background generally not a problem
    ☞ high statistics (10^3–10^5 events) and short pulse (10 – 20 sec.)
  - neutronisation burst or tail of the spectrum
    ☞ require a small(er) background
    ☞ **To be determined in the Design Study**

- Diffuse
  - Some signal-to-background estimation done (Tab. 7)
    MEMPHYS (43–109)/47
    LENA (CUPP) (20–230)/8
    GLACIER (40-60)/30
    *More studies are needed to estimate the background at the new Fréjus laboratory
  - Is this background information satisfactory ?

☞ **To be determined in the Design Study (?)**

Geo-Neutrinos [page 28 – 29]

- LENA
  - $\bar{\nu}_e + p \longrightarrow e^+ n$: gives clear signal
  - reactor neutrino background rate at CUPP $\sim$240 year^{-1} [1.8–3.2 MeV] and $\sim$2200 year^{-1} [1.8–8 MeV]
  - radio impurities (^{210}Po) are serious background source (as shown by KamLAND)
    ☞ Borexino CTF: ^{210}Po rate can be reduced
    $\Longrightarrow$ less than 10 ^{210}Po events per year in LENA
  - Background due to decay of ^{9}Li
    ☞ estimation from KamLAND
  - Muon background at the level of $\approx$1 event per year (at CUPP)

  $\Longrightarrow$ **1 (0.3) TW geo-reactor could be identified at a statatistical level of better than 4σ after one (10) year of measurement**

  $\Longrightarrow$ **Does not need to be included in the Desing Study (?)**
    - neutrons, γ's, ...

Geo-Neutrinos [page 28 – 29]

- MEMPHYS

Atmospheric Neutrinos [page 24 – 28]

Resources & Schedule

- Resources
  - three Post-Docs for two years; one for each detector
    (third year would be paid by the host institute)

- Schedule
  - period 2008 – 2010 (three years)
  - milestones
    - ☞ 2008: solar-ν and SN-ν background,
      2009: proton decay and geo-ν background
      2010: atm-ν background, ...

    (in reality, should be more flexible taking into account different detector properties)
  - deliverables