The Speed and Lifetime of Cosmic Muons

Administrative matters

Before you come to the first session in the laboratory, you should have planned your work! In particular, you should present **electronic coupling schemes** using the available modules for treating the detector signals in the two measurements (speed and lifetime). You should also have ideas about the **calibrations** and **background sources/reduction**. The laborative exercise is divided in two parts, since you need to collect data for about a week to get enough statistics for the lifetime measurement. On the first day you should expect to spend about 8 hours in the laboratory (of course depending you the quality of your preparations :o) !). The work to be done on the second occasion usually takes two hours. Bring a **PC-floppy** for this time!

Experimental set-up

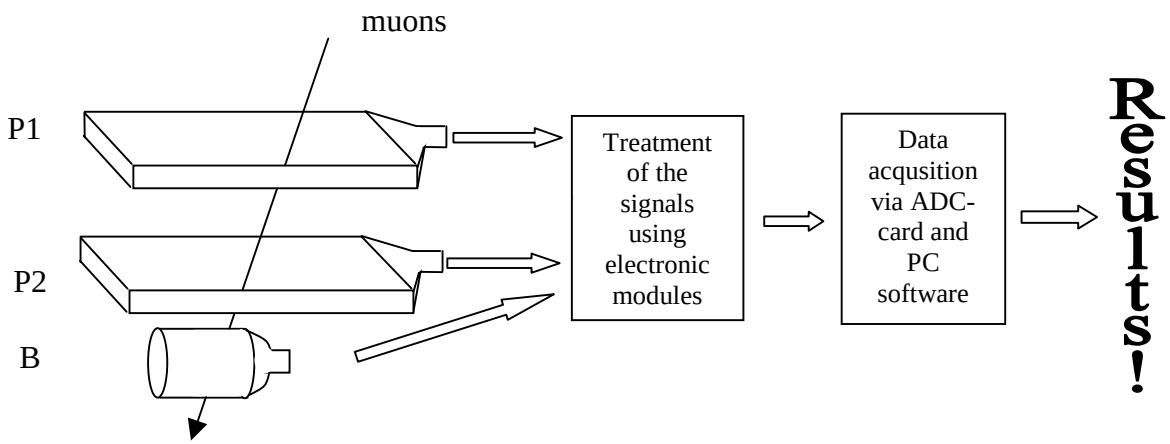

Fig. 1: Schematical setup of the scintillator detectors with photomultiplier (PM) tubes.

List of equipment available in the lab

- Three scintillator detectors as depicted in Fig. 1 with HV-supplies
- Cables of differing lengths (NIM standard)
- Converters between BNC-NIM standards
- One oscilloscope
- Electronic modules
    - Two constant fraction discriminators (CFD's) that take an incoming signal and give a logical pulse out.
    - Two delay modules that delay incoming pulses 1.7 ns - 64.7 ns.
    - One delay module that delays incoming signals 0.25 μs - 4 μs.
    - A logic module which operates on the incoming signals *A* and *B* as *A* OR *B* = *X*. All signals can be negated ($\bar{A}$, $\bar{B}$, $\bar{X}$). The length of the second out signal *Y* can be changed, i.e. a gate can be created.
    - A time-to-amplitude converter (TAC) which needs two incoming signals, one *start* and one *stop*. The amplitude of the out signal is proportional to the time difference between *start* and *stop* (min. conversion time is 10 ns).

- Manuals for all electronic modules
- Some radioactive samples
  - ^{241}Am (α-emitter, E_α = 5.64 MeV)
  - ^{60}Co (β^--emitter, the daughter ^{60}Ni gives two simultaneous photons, $E_{\gamma 1}$=1.17 MeV, $E_{\gamma 2}$ =1.33 MeV)
  - ^{22}Na (β^+-emitter, the daughter ^{22}Ne gives one photon, E_γ = 1.26 MeV
- PC with analog to digital converter (ADC) and data acquisition program

To think about BEFORE the first lab-day

- How do you want to measure *1)* speed and *2)* lifetime of the cosmic muons using the set-up and other material available?
- How should you treat the signals to get your results? Make coupling schemes!
- How do you want to calibrate your measurements? Absolute or relative calibrations? What should you think of in general to make a good calibration?
- What time ranges are involved in your measurements (ms? μs? ns? ps?)
- What background sources can be present and how will they disturb your measurements? How can you minimize them?

References

Introductory nuclear physics, K. S. Krane, (scintillator detectors)
Subatomic physics, H. Frauenfelder , E. M. Henley (detectors, cosmic rays, muons)
Scientific American Quarterly, Vol 9 No 1, *Magnificent Cosmos* p.62**; Scientific American** Jan 1997, Cronin et al., *Cosmic rays at the high energy frontier*
Scientific American Nov 1999, S. Smith, J. Cutts, *Floating in space*
Science, Vol 259 p 177, G. Taubes, *Astronomers turn new eyes on the Cosmic Sky*

Important stuff

Responsible person: Karin Markenroth
room: F5128
phone: 772 32 58
email: karin.markenroth@fy.chalmers.se
WWW: http://fy.chalmers.se/subatom/f2bkm/

The laboratory is situated in Forskarhuset, floor 5, room F5218.
Information about the project can be found on the web-page:
http://fy.chalmers.se/subatom/f2bkm/muons99.html
(links from my page and http://fy.chalmers.se/subatom/)
Here you can check the status of your report, follow some interesting (?) links, and possible news will also be posted here.
The report should be handed in to Karin (or put it in her mailbox), and it can be fetched from her office (ask someone to let you in if she's not there!).

The report HAS to be handed in before 1 June 2000 unless you want to redo the project next year!