ON TAGGING NEUTRINOS IN A HIGH-BAND BEAM

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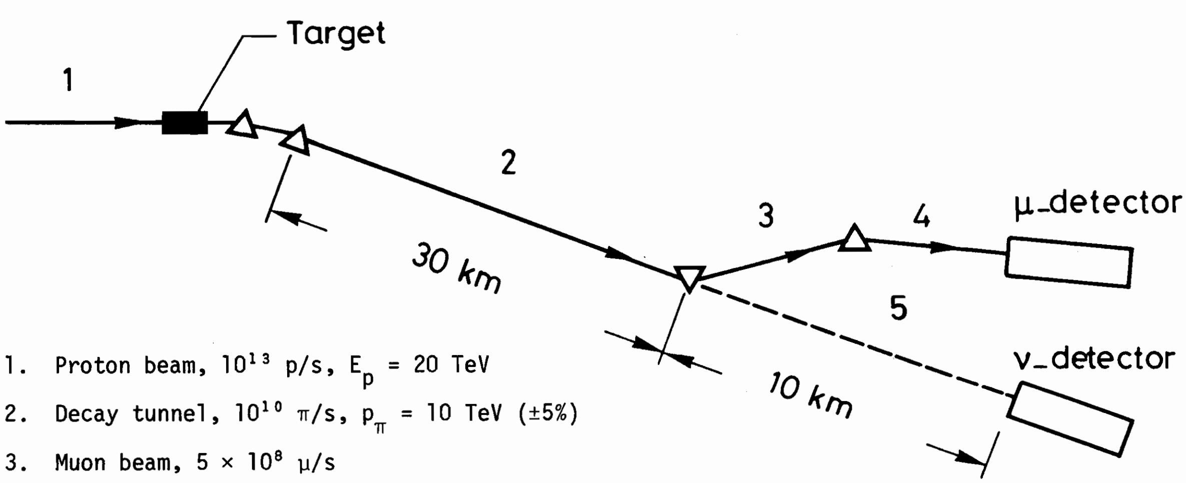
The geometry of a high-band muon beam has the capability not only of running muon and neutrino experiments simultaneously but also of having a tagged neutrino beam with a reasonable event rate.

The main parameters of the muon beam are presented in Fig. 1 *). For 10^{13} protons/s on the target (1), there will be, in a 30 km decay tunnel (2), an average of about 10^{10} pions/s with an energy $\sim$ 10 TeV and for a typical momentum band $\Delta p = \pm 5\%$. Out of these pions about 5% will decay in the decay tunnel and produce 5×10^8 muons/s and, correspondingly, neutrinos with a wide energy spectrum. The neutrino energy band will rise to $\simeq$ 4 TeV. The second part of the muon channel (3, 4) can accept 20% of the total muon band, thus bringing down the muon flux to $\sim 10^8$ muons/s. If this part of the muon channel is tuned to a certain momentum p_μ, the energy of corresponding neutrinos will be fixed by a simple relation

$$E_\nu = E_\pi - E_\mu \ .$$

In order to get the highest energy neutrinos, this part of the muon beam should be tuned to the lowest possible energy (causing a certain disadvantage for muon experiments). For a 6 TeV muon energy, the neutrino energy will be maximum and reach 4 TeV.



1. Proton beam, 10^{13} p/s, E_p = 20 TeV
2. Decay tunnel, 10^{10} π/s, p_π = 10 TeV (±5%)
3. Muon beam, 5×10^8 μ/s
4. Muon beam, $\sim 10^8$ μ/s
5. Neutrino beam

Fig. 1

*) All details of the high-band muon beam are contained in a report of Group III of these proceedings. They were given by N. Doble, to whom the author is greatly obliged.

In spite of the wide range of muon momenta in the end part of the muon beam, the momentum of each muon can be measured with a precision of $\sim$ 1%, so the uncertainty in the energy of the neutrino is defined essentially by a pion energy. The ±5% in pion momenta spread corresponds to ±0.5 TeV at 10 TeV pion energy, and so the same value will define an uncertainty for the neutrino energy.

The total counting rate of tagged neutrino events for a typical detector such as that of the CDHS Collaboration, which has about 4000 g/cm^2 in the target section, can be easily calculated. Assuming that the total (NC + CC) cross-section is still increasing linearly with energy as $\sigma_{tot} = 0.78 \times 10^{-38} \times E_\nu$ (GeV), and that the tagged neutrino flux is $\sim 10^8$ ν/s, the event rate is $\simeq$ 9 ev./s, which is slightly less than half of a total event rate. Therefore, increasing the muon momenta band, which would be accepted in a third part of a muon beam, would also increase the tagged event rate. It should also be noted that for a tagged neutrino beam, it will probably not be necessary to have a full 10 km shielding. If the halo of a muon beam is not high, then the majority of charged particles will be swept by bending magnets between sections 2 and 3. If the neutrino detector can be placed closer, say 1 km from the last bending magnets, the beam radius will decrease from 60 cm to $\sim$ 30 cm.