# DEEP INELASTIC MUON SCATTERING WITH DETECTION OF THE HADRON SHOWER ENERGY

G. Barbiellini

The progress on the knowledge of the deep inelastic lepton-nucleon process will come, with the existence of multi-TeV proton machines, from the large $Q^2$ range available. The muon-nucleon cross-section at the highest $Q^2$ allowed in a 20 TeV proton machine is like the weak neutrino-nucleon cross-section. Very long targets are needed to provide the large number of scattering centres necessary to study the rare high $Q^2$ events. An example of a muon scattering experiment with long target is the CERN-SPS experiment NA4. The target is a 50 metre long $H_2$ cylinder surrounded by toroidal iron magnets. The quoted resolutions on the scattered muon are $\Delta p/p \simeq 8\%$, $\Delta Q^2/Q^2 \simeq 5\%$ and $\Delta\theta/\theta \simeq 10\%$ at the SPS energy. Extrapolation of iron core magnet to higher energies will not significantly affect performance.

A way to improve the angular and momentum resolution on the scattered muon in the TeV region has been presented at this meeting by Prof. H.L. Anderson. In this project the muon momentum is analyzed in a large aperture air core magnet powered by superconducting coils. For a space resolution of $\sim$ 100 μm the quoted momentum and angular resolution are $\Delta p/p \simeq \Delta\theta/\theta \simeq 2\%$.

In this note the possibility is presented to derive the momentum transfer $Q^2 = 4E_\mu E'_\mu \sin^2\theta/2$ of the deep inelastic reaction by measuring the muon momentum and the hadron energy.

Because of the relation due to energy conservation of the reaction

$$\mu N \to \mu' X, \quad E_\mu + M_N = E'_\mu + E_X$$

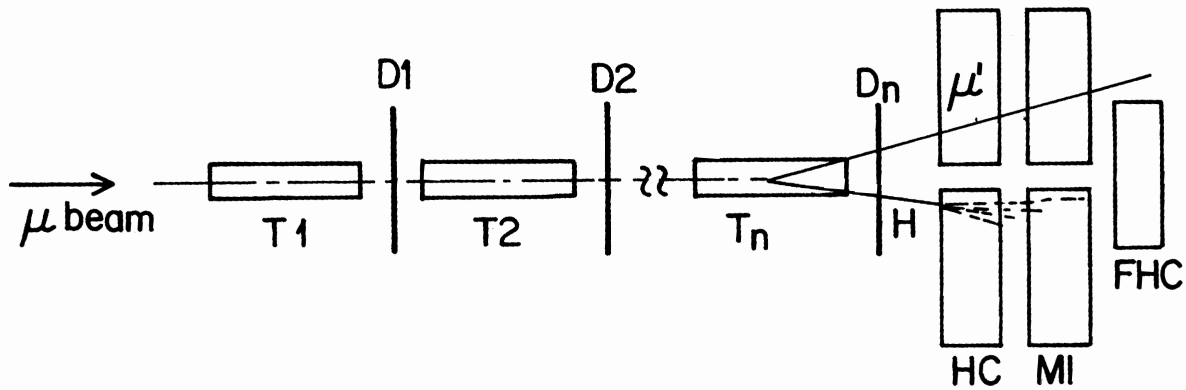
the $Q^2$ can be expressed as a function of $\theta_\mu$ and $E_X$

$$Q^2 = E_\mu (E_\mu - E_X)\theta_\mu^2$$

If the energy resolution of the present existing calorimeters can be extrapolated to the TeV region $\Delta E_X/E_X$ will be $\sim$ 1% and the hadron energy measurement will be competitive with the muon momentum measurement over a wide kinematical range. The identification of the scattered muon (an important task of lepton-nucleon scattering) is accomplished using a calorimetrically-equipped iron absorber.

The radiation energy loss of the muon in iron is substantial in the TeV region (muon critical energy $E_\mu \simeq 0.7$ TeV). The energy loss of the muon on a few metres of iron will provide a powerful signature for high energy muons and even a rough energy measurement $\Delta E_\mu/E_\mu \sim 0.2$.

The figure shows a sketch of a simple experimental arrangement for a muon deep inelastic scattering experiment, where $Q^2$ and $\nu$ are measured detecting the muon angle and the hadron energy.




$T_i$ = liquid H2 target
Di = detector for muon angle
HC= hadron calorimeter (FHC forward HC)
MI = muon identifier