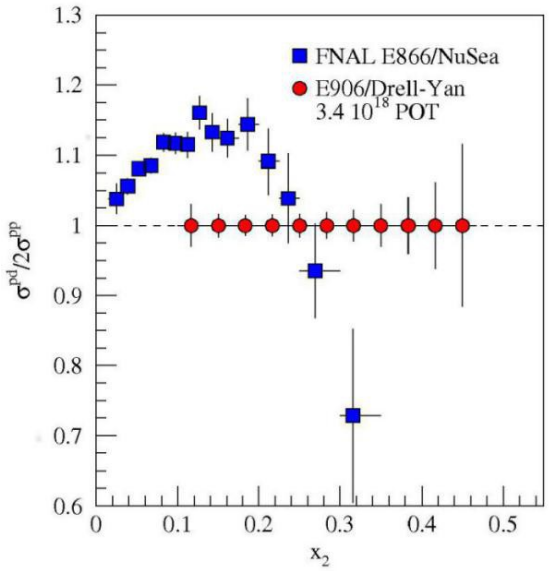
The SeaQuest/E906 Experiment: Study Sea Quarks in the Proton

1. Purpose

SeaQuest is an experiment to explore the antiquark distribution in the proton .

It was originally thought that the $\bar{u}$ and $\bar{d}$ distributions in the proton were equal; however, NMC at CERN discovered in 1991 that there are more $\bar{d}$ than $\bar{u}$ in the proton. E866 experiment at FNAL (Fermi National Accelerator Laboratory in USA) measured the ratio $\bar{d}$ / $\bar{u}$ as a function of x, the Bjorken scaling variable. These are the blue squares in the plot shown below. A large asymmetry between $\bar{d}$ and $\bar{u}$ was observed.



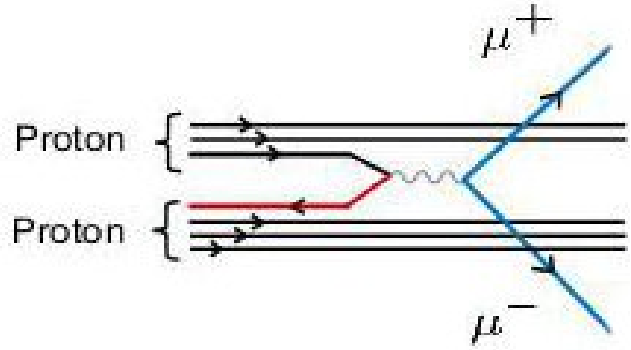
In the plot the deviation of the cross section ratio from 1 means the deviation of $\bar{d}$ / $\bar{u}$ from 1:

$$\left.\frac{\sigma^{pd}}{2\sigma^{pp}}\right|_{x_b \gg x_t} \approx \frac{1}{2}\left[1 + \frac{\bar{d}(x_t)}{\bar{u}(x_t)}\right]$$

The SeaQuest experiment at FNAL aims to determine the distribution ratio $\bar{d}$ / $\bar{u}$ at x=0.2-0.45 with higher accuracy than previous experiments. The red points in the plot only show the expected accuracy of the SeaQuest data.

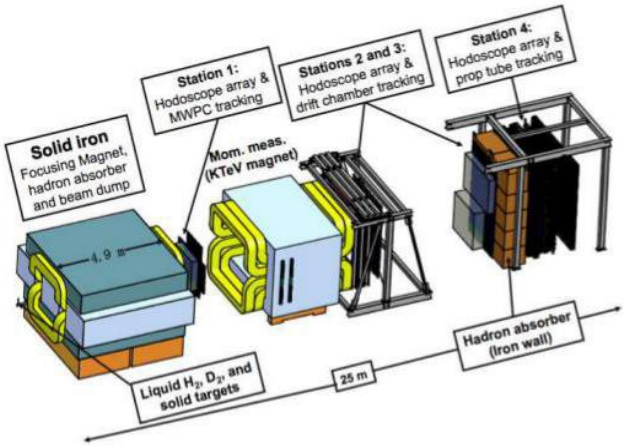
2. Method

In the SeaQuest experiment, the Drell-Yan process is used. In the Drell-Yan process an antiquark from one hadron and a quark from another hadron annihilate and form a virtual photon which then decays into oppositely charged muons. Below is the Feynman diagram of the Drell-Yan process.



3. Muon-Pair Spectrometer

The proton beam of 120 GeV and hydrogen and deuterium fixed targets are used. The beam energy used in the E866 experiment was 800GeV and decreasing the beam energy to 120 GeV causes an increase in muon production rate and a decrease of background muons produced from other processes. The SeaQuest spectrometer is shown below.



There is a magnet and drift chambers for tracking and momentum determination of charged particles. Hodoscopes are used as triggers for the drift chambers.

4. Conclusion

The SeaQuest/E906 experiment was commissioned in 2012 and the data that will be taken will greatly increase our knowledge of the proton structure. In particular, this experiment will investigate antiquarks in the proton at high values of x.