# Probing flavor asymmetry of antiquarks of the proton in the E906/SeaQuest experiment

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E906/SeaQuest is an extension of the earlier Drell-Yan experiments at Fermi National Accelerator Laboratory (Fermilab), such as E772 and E866/NuSea[1)], and it studies the internal structure of the proton at the parton level using the Drell–Yan process. In the leading order, the Drell–Yan process is described by the quark–antiquark annihilation process: $q + \bar{q} \rightarrow \gamma^* \rightarrow \mu^+ + \mu^-$. SeaQuest uses a 120-GeV proton beam extracted from the Fermilab Main Injector.

The ratio $\bar{d}/\bar{u}$ was measured in the Bjorken $x$ range $0.015 < x < 0.35$ in the E866 experiment. The statistically precise part of the data in the range $0.015 < x < 0.2$ tends to agree with several models, such as the meson cloud model. However, the data appear to deviate from these models in the larger $x$ region. SeaQuest will determine the ratio up to $x = 0.45$ more precisely than the E866. The SeaQuest spectrometer consists of four tracking stations. Each station has drift chambers or drift tubes for tracking and hodoscopes for trigger. The Japanese group is in charge of the drift chambers of the third station. Two drift chambers are aligned at the station to cover the large acceptance. SeaQuest completed a two-month commissioning run in spring 2012. After an upgrade, a two-year physics run began in fall 2013.

In the commissioning run, we successfully reconstructed the di-muon mass distribution, and a $J/\psi$ peak was clearly observed (Fig. 1). The mass resolution was $\sim 0.3$ GeV, which meets the requirement. This proves that the detectors and tracking software work adequately. After the commissioning run, three main hardware upgrades were performed. The first one was an upgrade of the beam quality. During the commissioning run, we observed high-multiplicity events because the beam had high instantaneous intensity. This made the track reconstruction difficult. An improvement of the duty factor was confirmed in the current run. The beam tuning is now ongoing, and we will have a full-intensity beam ($10^{12}$ protons per second) once it is completed. The second main upgrade is the installation of a Cherenkov detector in the beam line to measure the beam intensity at 53 MHz RF frequency. This allows us to determine the absolute cross section of the Drell–Yan process and to generate a veto trigger in order to avoid the high-intensity part of the beam. The last main upgrade is the improvement of the hodoscopes and drift chambers. For hodoscopes, we upgraded the existing PMT bases with a new circuit board to achieve higher rate capabilities. For drift chambers, one new chamber was constructed to ensure a larger acceptance at the third station. The chamber has 5,300 wires, and we manually constructed it in 2012. The chamber was installed at the bottom part of the third station. The construction of another new drift chamber is ongoing. It will be also installed at the first station.

After the current physics run began, we were working on the optimization of every component for stable data accumulation. Our current focus is to optimize the trigger system. The system examines the hit pattern of the hodoscopes to identify the pattern characteristics of the high-mass muon pairs produced from the Drell–Yan process or $J/\psi$ decay. We are now trying to suppress the background as much as possible through the hit-pattern study. The preliminary result of the mass distribution shows a suppression of the background compared to the distribution obtained in the commissioning run. Once the optimization is completed, we will start taking the Drell–Yan data. The data accumulated in the next two years will have a significant impact on our understanding of the internal structure of the proton.

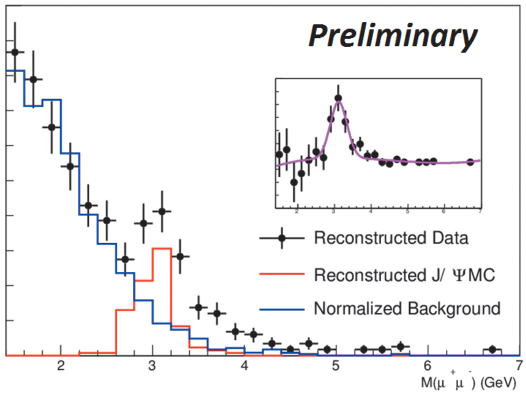


Fig. 1. Di-muon mass distribution reconstructed using the data taken in the commissioning run. The $J/\psi$ peak is clearly observed. The inset shows the mass distribution in which the normalized background is subtracted.

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References

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