# 1 FNAL Experiment 866

by
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FNAL Experiment 866 (E866) is a high statistics measurement of the relative yield of Drell-Yan dimuon pairs from p+p and p+d collisions. The collaboration consists of ACU, Argon National Laboratory, Fermi National Accelerator Laboratory, Georgia State University, Illinois Institute of Technology, Los Alamos National Laboratory, Louisiana State University, New Mexico State University, Oak Ridge National Laboratory, Texas A&M University and Valparaiso University. It is vital that funding be maintained for ACU since the full analysis of the main data set is the responsibility of our graduate student, Rusty Towell.

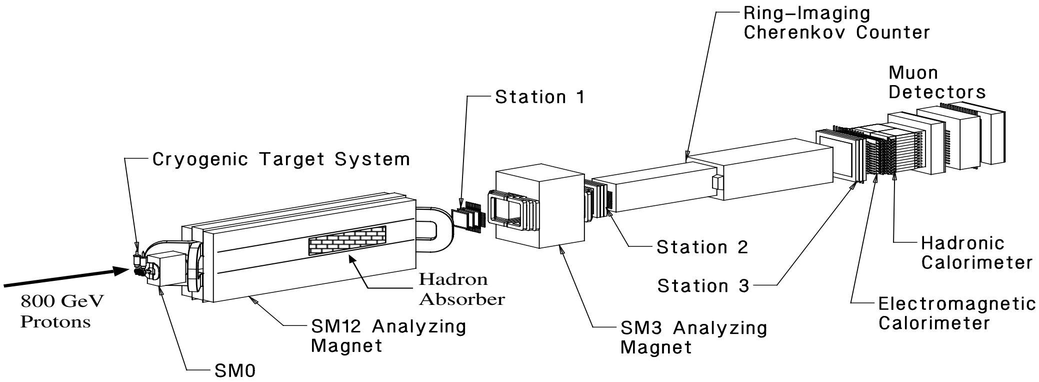


Figure 1: The E605/E772/E789/E866 Spectrometer.

E866 used the E605/E772/E789 spectrometer located in the Meson East area at FNAL. The main modifications from the E789 configuration involved the removal of the silicon strip vertex detector, the installation of a magnet in front of the big dipole magnet, upgrading the trigger to a programmable VME based trigger, and the enlargement of the station one detectors. ACU helped with all of these modification and was responsible for rebuilding the station one hodoscopes.

Data was taken on 50-cm-long liquid hydrogen (LH2) and liquid deuterium (LD2) targets. The target mechanism is capable of switching between the two targets, plus an empty target vessel, between each beam spill (at FNAL the protons are delivered over a 20 second period once per minute). At an intensity of $2x10^{12}$ protons/spill, the rates that the detectors handled were quite high. This is one of the reasons the experiment used the existing E605/E772/E789 spectrometer since it has excellent rate capabilities. The ability to cycle rapidly between the targets helped limit the systematic errors to 1%.

## 1.1 ACU's contribution to E866

For E866, ACU was responsible for maintaining the hodoscopes, which we rebuilt for E789 then again for E866. During the past four summers ACU had several students involved with rebuilding and recommissioning the hodoscopes. Station 1Y was expanded to 16 counters tall and Station 1X was completely rebuilt to cover the extended Y counters. This increased the solid angle for the D-Y events of interest by roughly a factor of 2. The careful work of these students in preparing the hodoscopes was demonstrated by the hodoscopes outstanding performance. Not a single channel of the hodoscopes failed once during the year long experiment.

Since some many students had worked for so many summers getting the spectrometer ready for beam, it was very fulfilly for them to actually help take data. During the past summer (1997) five ACU undergraduate students worked on E866 (two of these were supported by LANL and three were supported by this grant). These students contributed significantly to the experimental effort by quickly learning how to run the experiment. This allowed them to take shifts where they were solely responsible for operating the spectrometer. In addition to taking shifts each student performed other tasks including preliminary analysis, monitoring the gas system, copying data tapes, and filtering the study triggers from all of the data tapes. ACU has been able to make a very positive impact on experiments by providing manpower for labor intensive tasks and will continue to be an important partner in the Fermilab program.

While the undergraduate students were enjoying seeing the completion of several summers of work, Isenhower was the acting spokesman. Pat McGaughey who is the E866 spokesman and had spent a year living at Fermilab returned to Los Alamos. So Isenhower was the acting spokesman for much of the summer. He supervised the daily activities of data taking, interfaced with the lab in administrative matters, and managed 5 undergraduate students and one graduate student.

The funding for graduate student support has been to support Rusty Towell to work full-time on E866. Towell is a student at the University of Texas at Austin, where he took his course work and will receive his Ph.D. Isenhower will serve as co-chair of Towell's graduate committee along with Dr. Peter Riley of U.T., and Sadler will serve as one of the members of Towell's graduate committee. Towell was at FNAL throughout the experiment. He was one of the students involved in the previous three summer's work, and he has played a major role in supervising our undergraduate students during the past summer. Towell was very valuable to the collaboration in maintaining and repairing various TDC, hodoscope, prompt tube, and Nevis Transport modules. Having someone on site at FNAL full time during the academic year has been extremely helpful in keeping ACU actively involved in this important experiment. When data taking was completed and the spectrometer was decommissioned, he moved to LANL to analyze the data. He has been assigned the full analysis of the $\bar{d}/\bar{u}$ data, which he will use as his dissertation topic.

During the past year Towell has presented E866 preliminary results in three talks. He was invited to talk at DIS 97 (Do you want the write-up referenced? How?) and two informal talks to members of other experiments at FNAL. In February of this year Towell will give a high energy nuclear physics seminar at the University of Texas at Austin. Then in March Towell will give an invited talk at Moriond. This trip will be funded out of the ACU nuclear physics grant.

## 1.2 Measurement of $\bar{d}/\bar{u}$ in the Proton

Recent experiments have indicated that the light quark content of the nucleon sea is not flavor symmetric. Therefore, E866 set out to measure the ratio of $\bar{d}/\bar{u}$ in the proton over the interval $.02 < x_F < .35$. This measurement was completed in March 1997. The remainder of the fixed target run at Fermilab was used to study the nuclear dependence of $J/\psi, \psi'$, and $\Upsilon$ production in a wide kinematic range. Since data taking ended in August 1997 we have made significant progress in the analysis. Our first results showing the ratio $\bar{d}/\bar{u}$ have been submitted for publication to Phys. Rev. Lett.

The abstract from this article states: "A precise measurement of the ratio of Drell-Yan yields from an 800 GeV/c proton beam incident on hydrogen and deuterium targets is reported. Over 140,000 Drell-Yan muon pairs with dimuon mass $M_{\mu^+\mu^-} \geq 4.5$ GeV/c$^2$ were recorded. From these data, the ratio of anti-down ($\bar{d}$) to anti-up ($\bar{u}$) quark distributions in the proton sea is determined over a wide range in Bjorken-$x$. A strong $x$ dependence is observed in the ratio $\bar{d}/\bar{u}$, showing substantial enhancement of $\bar{d}$ with respect to $\bar{u}$ for $x < 0.2$. This result is in fair agreement with recent parton distribution parameterizations of the sea. For $x > 0.2$, the observed $\bar{d}/\bar{u}$ ratio is much nearer unity than given by the parameterizations."

Three different spectrometer settings were employed to optimize data collection at low, intermediate, and high masses of the muon pair. The data collected in the high mass setting are relatively free of the rate dependence efficiencies and the random coincidences that affect the other data sets. Therefore, the initial Phys. Rev. Lett. only reports the results from the high mass data set. The analysis of the other data sets is progressing in a timely manner. The first and second pass analysis have been completed and currently the systematic effects are being studied. The analysis of the remaining data sets will extend the $\bar{d}/\bar{u}$ measurement down to smaller $x$ values. This will provide an independent check of the NMC result of $\int_0^1 \left[\bar{d}_p(x) - \bar{u}_p(x)\right] dx = 0.147 \pm 0.039$.

The data taken during the run extension is also currently being analyzed by other members of the collaboration. The first pass, and in most cases the second pass, analysis of all of this data is complete. This data analysis will serve as the thesis topic for several graduate

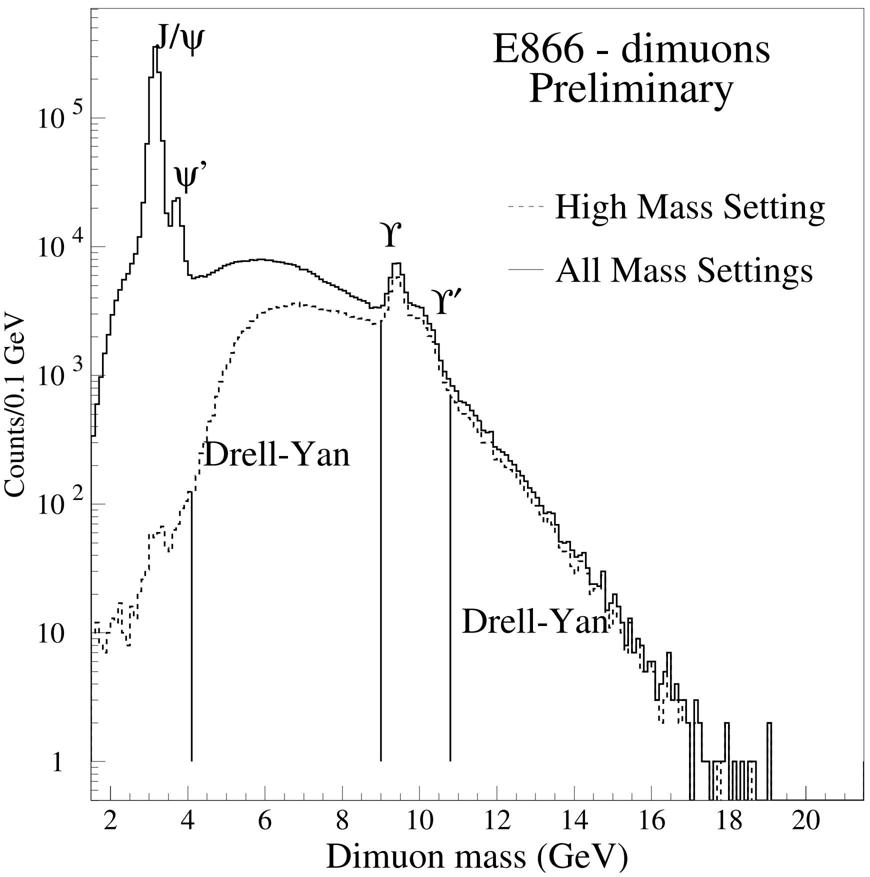


Figure 2: Preliminary Mass Spectrum.

students from other universities.

| Student | University | Analysis |
|---|---|---|
| Eric Hawker | Texas A & M Univ. | High Mass $\bar{d}/\bar{u}$ Measurement |
| Ting Chang | New Mexico State Univ | Angular Dependence of $J/\psi$ Production |
| Bill Lee | Georgia State Univ. | Nuclear Dependence of $J/\psi$ Production |
| Jason Webb | New Mexico State Univ | Absolute Cross Section Measurement |
| Stephan Klinksiek | Univ. of New Mexico | Single Muon Production |