

Measuring the \bar{u}/\bar{d} Asymmetry in the
Proton Sea: Fermilab E866

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Outline

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 - Gottfried Sum Rule and NMC
 - Drell-Yan and NA51
- FNAL E866: NUSEA experiment
 - The E866 spectrometer
 - The \bar{u}/\bar{d} run
- Preliminary Results
 - Raw Data
 - $\sigma^{pd}/2\sigma^{pp}$ for Drell-Yan events

Gottfried Sum Rule

$$\begin{aligned} I_G &= \int_0^1 (F_2^p - F_2^n) \frac{dx}{x} \\ &= \int_0^1 \sum_i e_i^2 [(q_i^p(x) + \bar{q}_i^p(x)) - (q_i^n(x) + \bar{q}_i^n(x))] dx \end{aligned}$$

Assuming Isospin Symmetry ($u_p(x) = d_n(x)$)

$$I_G = \frac{1}{3} - \frac{2}{3} \int_0^1 (\bar{d}^p(x) - \bar{u}^p(x)) dx$$

NMC Results

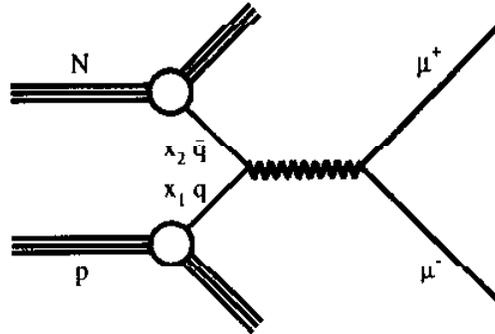
$$I_G = 0.235 \pm 0.026 \neq \frac{1}{3}$$

Explanations:

- Uncertain extrapolation for $0.0 \leq x \leq 0.004$
- Isospin Symmetry violation between proton and neutron
- $\bar{u}_p(x) \neq \bar{d}_p(x)$

Drell-Yan and $\bar{u}_p(x)/\bar{d}_p(x)$

$$pN \rightarrow \mu^+ \mu^- X$$



$$\sigma^{pN} \propto \sum_i e_i^2 [q_i(x_1)\bar{q}_i(x_2) + q_i(x_2)\bar{q}_i(x_1)]$$

$$x_f = x_1 - x_2 \quad \text{mass}^2 = x_1 x_2 s$$

- Compare Drell-Yan yields from Liquid H₂ and D₂ targets to extract \bar{u}/\bar{d}
NOTE: Isospin symmetry must also be assumed

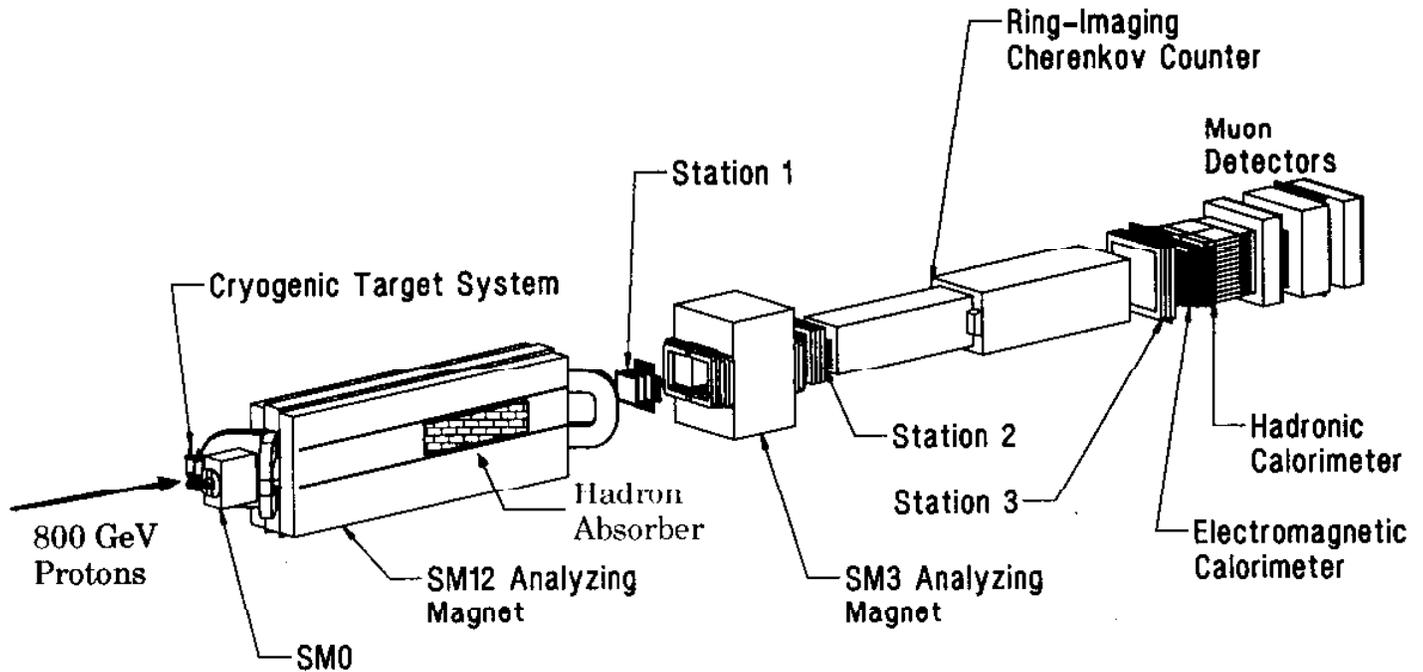
$$\left. \frac{\sigma^{pd}}{2\sigma^{pp}} \right|_{x_f > 0} \approx \frac{1}{2} \left(1 + \frac{\bar{d}_p(x)}{\bar{u}_p(x)} \right)$$

- NA51 (CERN) found on LH₂ and LD₂
 $\bar{u}/\bar{d} = 0.51 \pm 0.04 \pm 0.05$ at $x \approx 0.18$

FNAL E866: NUSEA Experiment

The goal of the E866 experiment is to measure $\bar{u}_p(x)/\bar{d}_p(x)$ to the order of 1% accuracy for $0.05 \leq x \leq 0.15$ and with lesser statistical accuracy out to $x \simeq 0.3$.

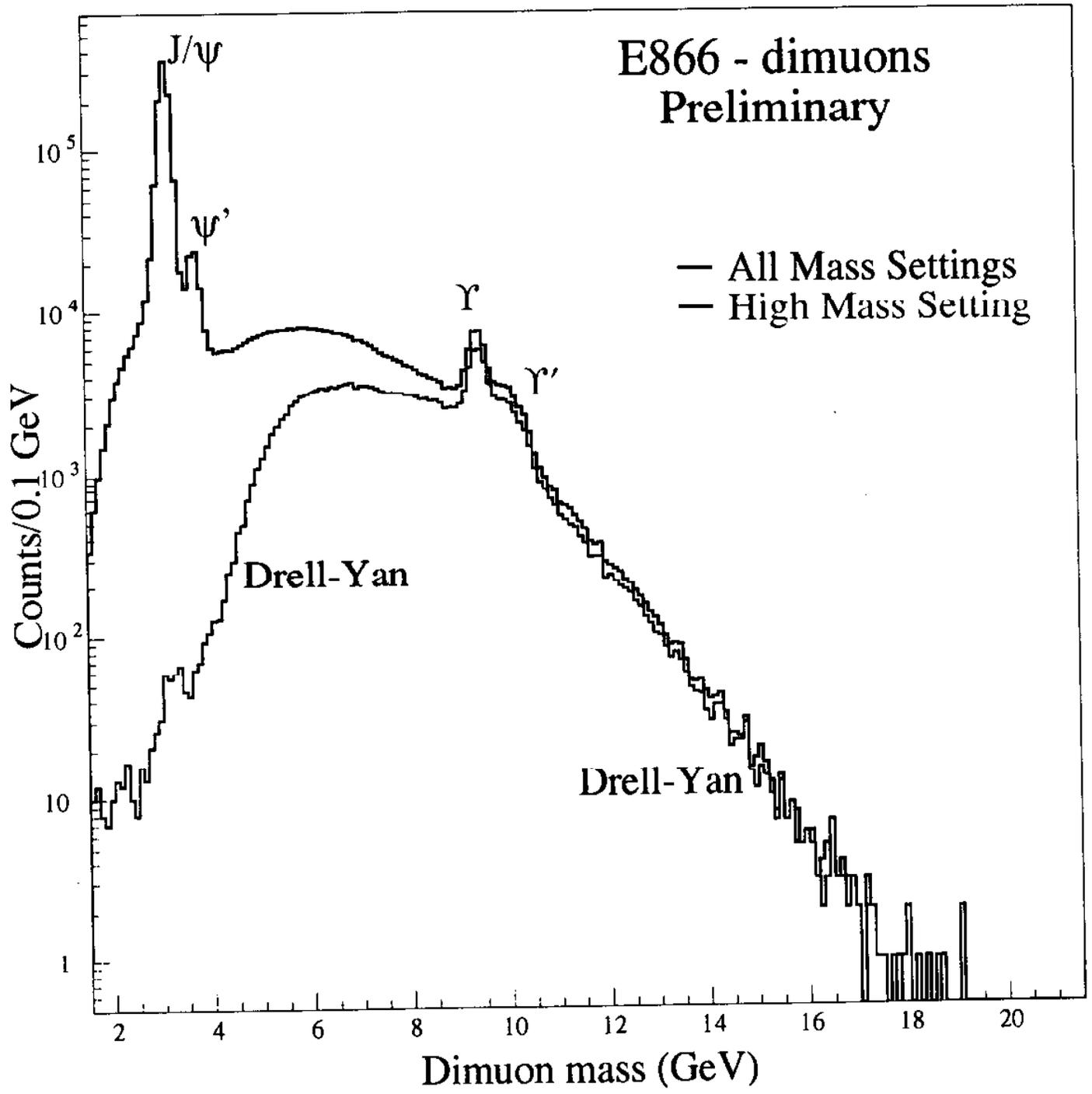
FNAL E866 (NUSEA) Spectrometer



- Forward x_f , high mass dimuon spectrometer
- Liquid H_2 , D_2 and empty target flasks
- μ identification is made possible by use of a thick absorber wall
- Two acceptance defining magnets
- Four tracking stations, and one momentum analyzing magnet

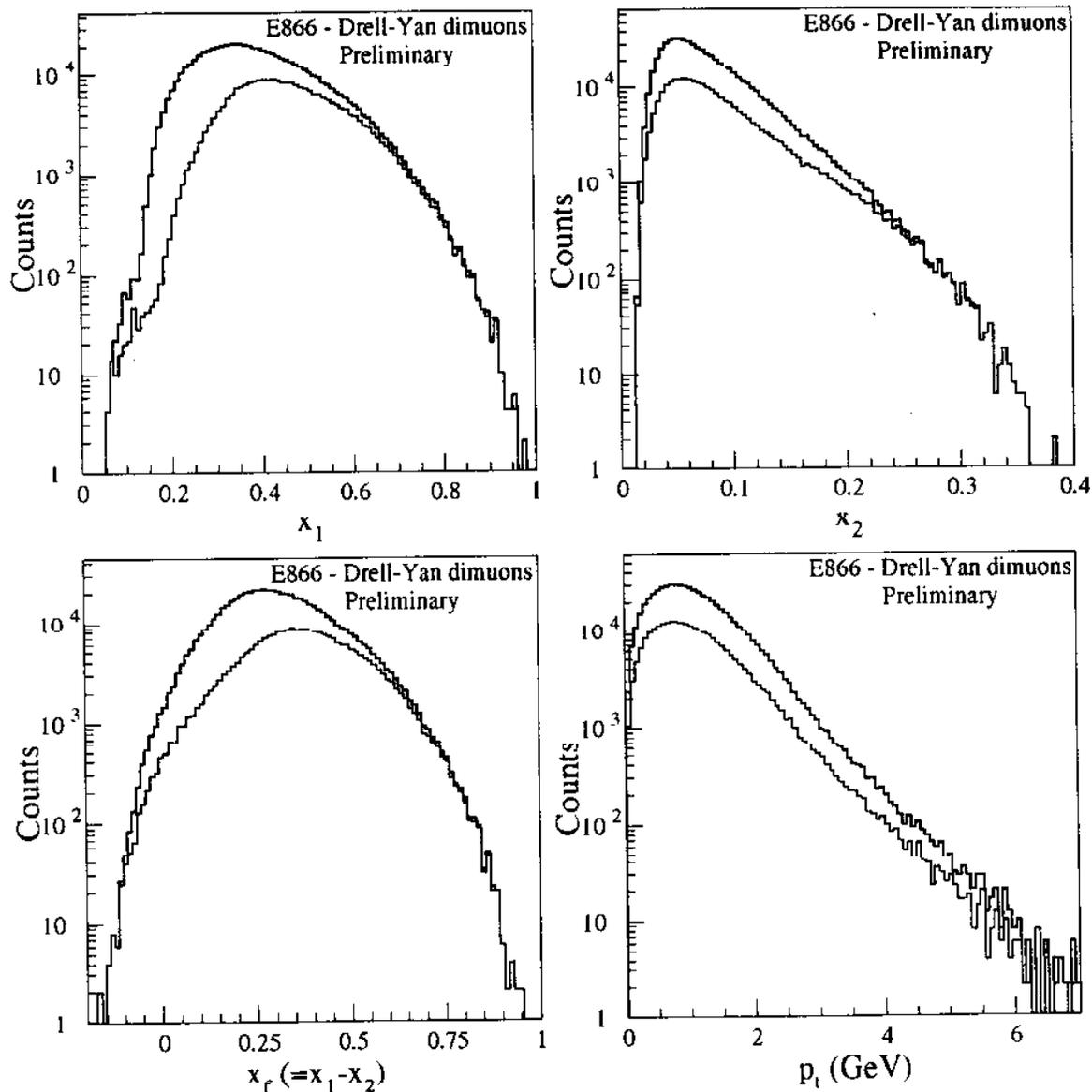
FNAL E866: The \bar{u}/\bar{d} run

- Three different magnet settings were used to take data in the low, intermediate, and high mass regions
- Systematic effects such as randoms, and rate dependence are found at the few percent level in both the low and intermediate mass settings. The data from the high mass setting is largely free of these effects.
- Six month long \bar{u}/\bar{d} run ended 3/24/97!!
- Received over 1.3×10^{17} 800 GeV protons on target during run
- Over 350,000 Drell-Yan events on tape
- Over 1×10^6 J/ψ events, and over 20,000 Υ on tape

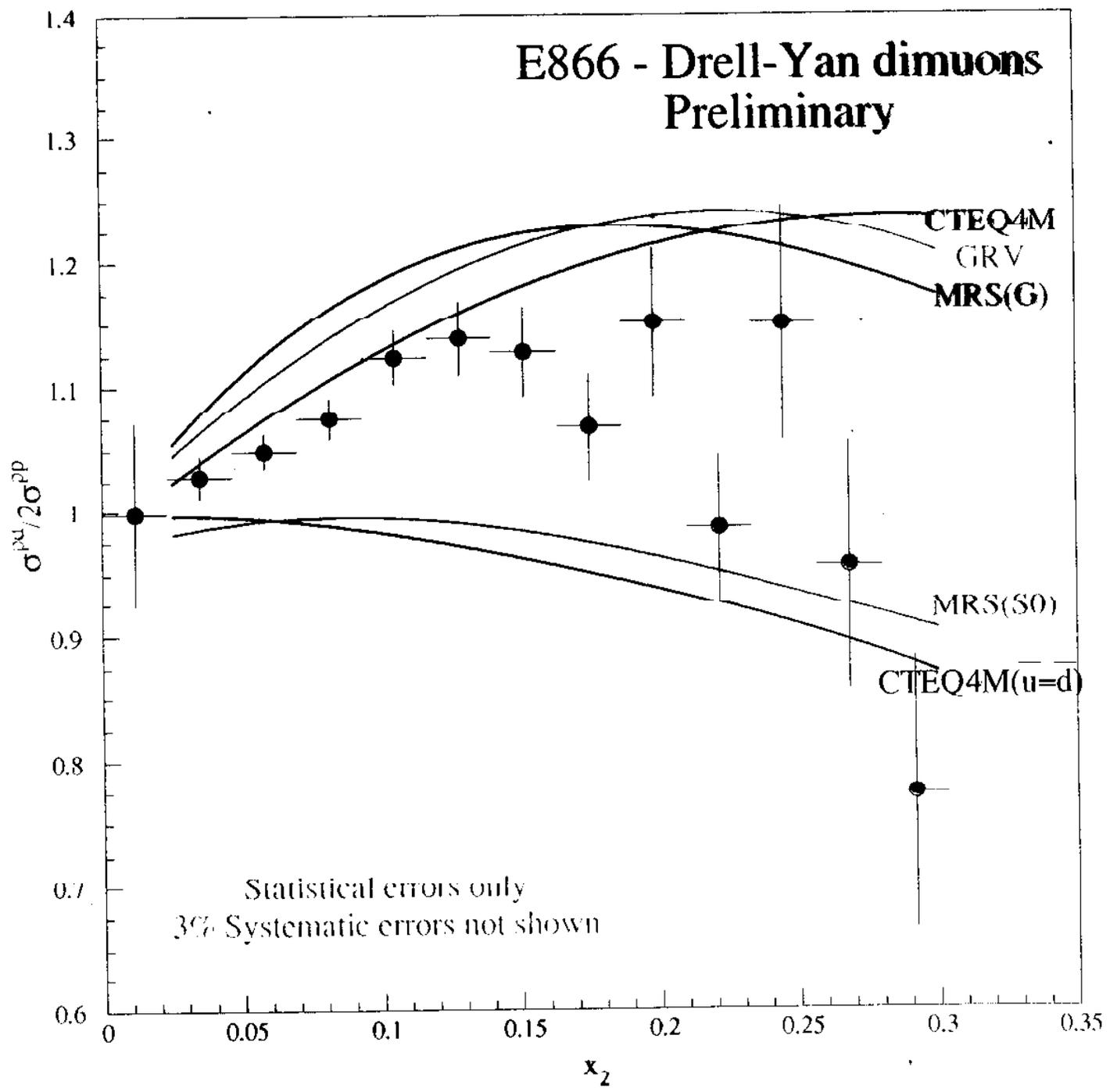


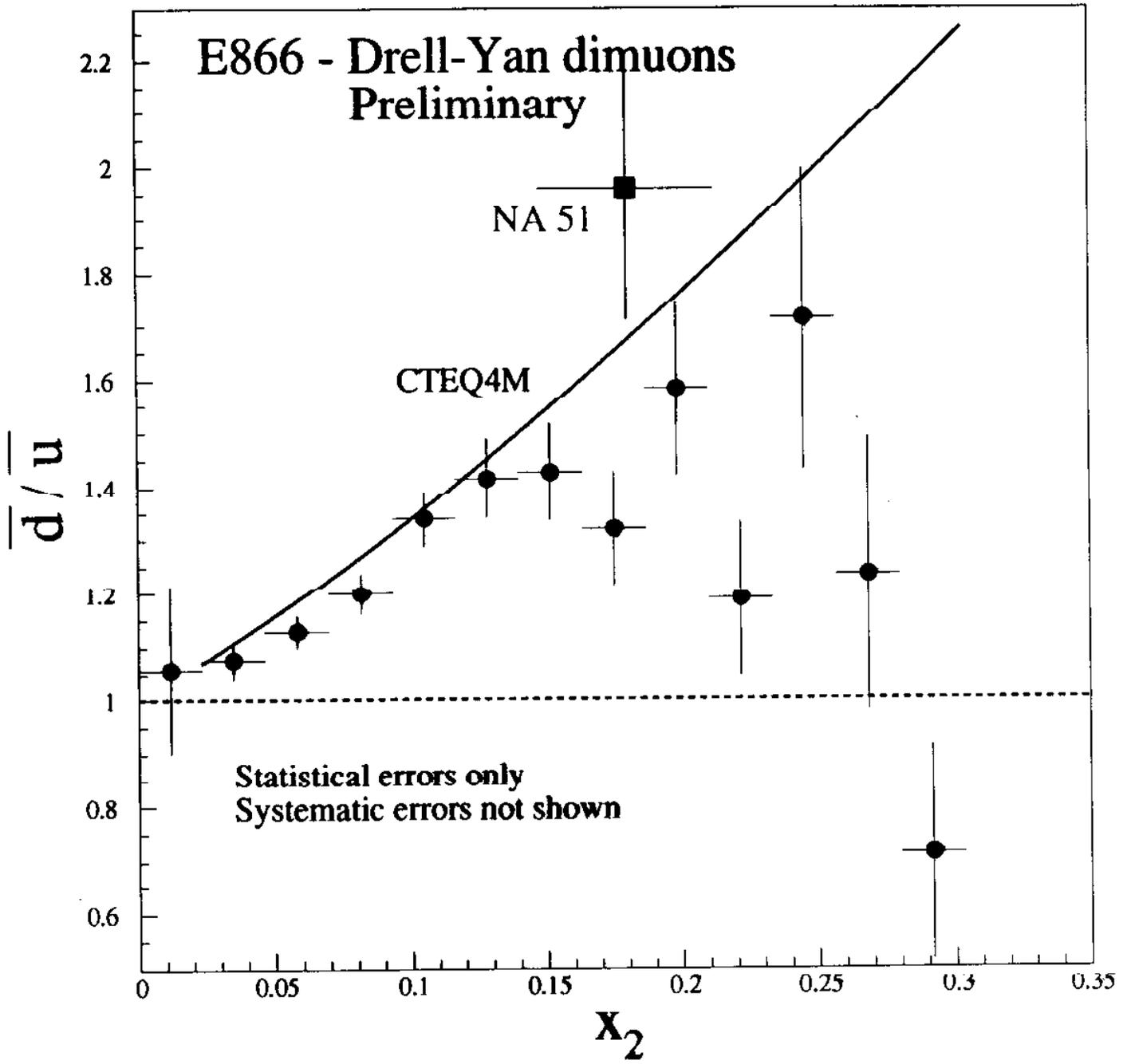
Preliminary Data!!

Kinematic coverage of Drell-Yan events



E866 - Drell-Yan dimuons Preliminary





Conclusion

- The preliminary results from FNAL E866 confirm both the NMC evidence that $\bar{u}_p \neq \bar{d}_p$ and the NA51 result that $\bar{d}_p > \bar{u}_p$.
- Our data for $x > 0.2$ do not agree with common parameterizations of the proton.
- The goal of E866 should be achieved after a full analysis of the data.