CEBAF PROPOSAL COVER SHEET

This Proposal must be mailed to:

CEBAF
Scientific Director's Office
12000 Jefferson Avenue
Newport News, VA 23606

and received on or before OCTOBER 31, 1989

A. TITLE:

A Measurement of the Electron Asymmetry in $p(\vec{e},e'p)\pi^0$ and $p(\vec{e},e'\pi^+)$ in the Mass Region of the $P_{33}(1232)$.

B. CONTACT PERSON:

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C. THIS PROPOSAL IS BASED ON A PREVIOUSLY SUBMITTED LETTER OF INTENT

/X/ YES
/ / NO

IF YES, TITLE OF PREVIOUSLY SUBMITTED LETTER OF INTENT

A Measurement of the Electron Asymmetry in $p(\vec{e},e'p)\pi^0$ and $p(\vec{e},e'\pi^+)$ in the Mass Region of the $P_{33}(1232)$.

D. ATTACH A SEPARATE PAGE LISTING ALL COLLABORATION MEMBERS AND THEIR INSTITUTIONS

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Proposal Received 10-31-89

Log Number Assigned PR-89-042

KES

contact: Burkert

Proposal 6

A Measurement of the Electron Asymmetry in $p(e,e'p)\pi^0$ and $p(e,e'\pi^+)n$ in the Mass Region of the $P_{33}(1232)$ for $Q^2 \leq 2(GeV/c)^2$.

The N* - Group

- In the CLAS Collaboration -

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Spokespersons: V. Burkert, R. Minehart

Abstract.

The goal of this measurement is to extract the terms $Im(S_o M^*_{1+})$ and $Im(S_{1+} M^*_{1+})$ in the region of the $P_{33}(1232)$ for $Q^2 \leq 3(GeV/c)^2$. These terms provide information on the scalar/longitudinal multipoles S_{1+} and S_o which is complementary to the information extracted from the unpolarized measurements. The second term is sensitive to the relative phases of the S_{1+} and M_{1+} and vanishes if both multipoles have the same phase. This is the case if the two multipoles contain resonant contributions from the $P_{33}(1232)$ only. Any deviation from zero would indicate the existence of additional nonresonant contribution to the S_{1+} multipole in the isospin 1/2 channel. The measurement will be done with the CLAS detector. A luminosity of $10^{34} cm^{-2} sec^{-1}$ has been assumed.

where the term with σ_e is only present in measurements with a polarized electron beam. σ_e can be isolated by measuring the cross section asymmetry (lepton asymmetry)

$$A_e = (\sigma(+)-\sigma(-))/(\sigma(+)+\sigma(-)) = \sqrt{\epsilon(1-\epsilon)}\sin\Phi\sin\theta^*\sigma_e/\sigma_o ,$$

where we have used σ_o as a short hand for the unpolarized cross section.

In the approximation that only s- and p-waves contribute to the cross section, and M_{1+} dominance (only terms containing the M_{1+} multipole are retained) one obtains the simple expression for σ_e:

$$\sigma_e \simeq - [\mathrm{Im}(S_{o+}M^*_{1+}) + 6\cos\theta^*\mathrm{Im}(S_{1+}M^*_{1+})]$$

By measuring the Φ and θ^* distributions the two terms can be separated. Possible contributions from higher partial waves will show up in deviations from a straight line in the angular distribution $\sigma_e(\theta^*_p)$. By making use of the large angle coverage of the LAS detector we intend to measure the full Φ and θ^* distribution. Measurement of the complete Φ distribution provides important information on systematic uncertainties of the experiment. Note that at $\Phi=0$ and $\Phi=180°$ the asymmetry must be $A_e=0$. The maximum sensitivity to the term $\mathrm{Im}(S_{1+}M^*_{1+})$ is obtained near $\theta^*=45°$ and $135°$. In order to separate s- and p-waves and possibly higher partial waves, full polar angle coverage is essential.

The processes

$$p(\vec{e},e'p)\pi^o \quad \text{and} \quad p(\vec{e},e'\pi^+)n$$

contain different isospin information. This information is important since the two channels contain different nonresonant contributions. The single pion production channel will be identified using the missing mass technique. In previous proposals we have already demonstrated that this technique can be applied for both channels, using the CLAS detector. The experiment will be carried out under the same conditions as the unpolarized measurement of proposal 1, therefore the Monte Carlo simulations can be applied immediately to this experiment as well. For details we refer to proposal 1.

Depending on the outcome of these measurements we would like to keep the option of measuring A_e for the reaction

V. Expected Accuracy.

As in the case of the unpolarized measurement we chose the following bin sizes to estimate the statistical accuracy of the experiment.

$$\Delta Q^2 = 0.2,\ \Delta W = 20\text{MeV}$$
$$\Delta\cos\theta^* = 0.166$$

In Figure 6 & 7, the expected statistical accuracy is shown assuming the following conditions.

Beam energy:	4 GeV
Running time:	1000 hours
Polarization:	P=0.5
Luminosity:	$10^{34}\text{cm}^{-2}\text{sec}^{-1}$

The measurement will span the Q^2 range from 0.5 to 2.0 GeV^2.

In the final analysis the Φ dependence of the asymmetry will be fitted to a functional form

$$A_e(\Phi,\theta^*,Q^2,W) = A(\theta^*,Q^2,W)*\sin(\Phi)$$

where all Φ bins contribute. Assuming that all Φ bins contain (within the statistical uncertainty) the same number of events, then the statistical uncertainty of the asymmetry measurement is

$$\delta A = \delta A_e/2\sqrt{\sum_i^n \sin^2(\Phi_i)}\ ,$$

where n is the number of equidistant bins between $\Phi = 0^\circ$ and 90°.

VI. Polarization Asymmetry at Higher Masses.

In this proposal we have concentrated on the region of the $\Delta(1232)$ resonance. However, at the same time we would also measure A_e in the higher mass region. Figure 8 shows A_e as predicted in the analysis of Boden & Kroesen. Similar conclusions regarding the sensitivity to various

5) The experimental program spans a large range in Q^2 with high rates at low Q^2 and low rates at high Q^2. We assume that the full range in Q^2 can be measured simultaneously.

6.) The experiment makes use of a polarized electron source. Although the 50% polarization that has been achieved with a GaAs cathode is sufficiently high to allow us to carry out the measurement, the experiment would greatly benefit from a higher polarization even if it is obtained at the cost of a reduced maximum beam current. A factor of two higher polarization would reduce the statistical error in the asymmetry by the same factor of two, or alternatively the running time of the experiment could be reduced by a factor of four to obtain the same statistics.

7.) It is essential that the polarization be monitored in the end station. An electron polarimeter based on Møller scattering with the two scattered electrons being measured in coincidence seems to be the best choice for measuring the polarization of a low or moderately high intensity beam. An accuracy of 2 to 3% (absolute) appears adequate.

8.) We estimate that the measurement can be carried within a running time of 1000 hours at 4 GeV beam energy, and within 300 hours at 2 GeV.

VIII. Data Analysis.

The data would be analyzed at CEBAF and at the University of Virginia.

References.

(1) M. Bourdeau, N.C. Mukhopadyay ; Phys.Rev.Lett.58,976(1987)
(2) G. v.Gehlen; Nucl.Phys.B26,141 (1971)
(3) N. Isgur, G. Karl; Phys.Rev.D19 ,7653 (1979)
(4) B. Boden, G. Kroesen; CEBAF RPAC II, eds. V. Burkert et al.

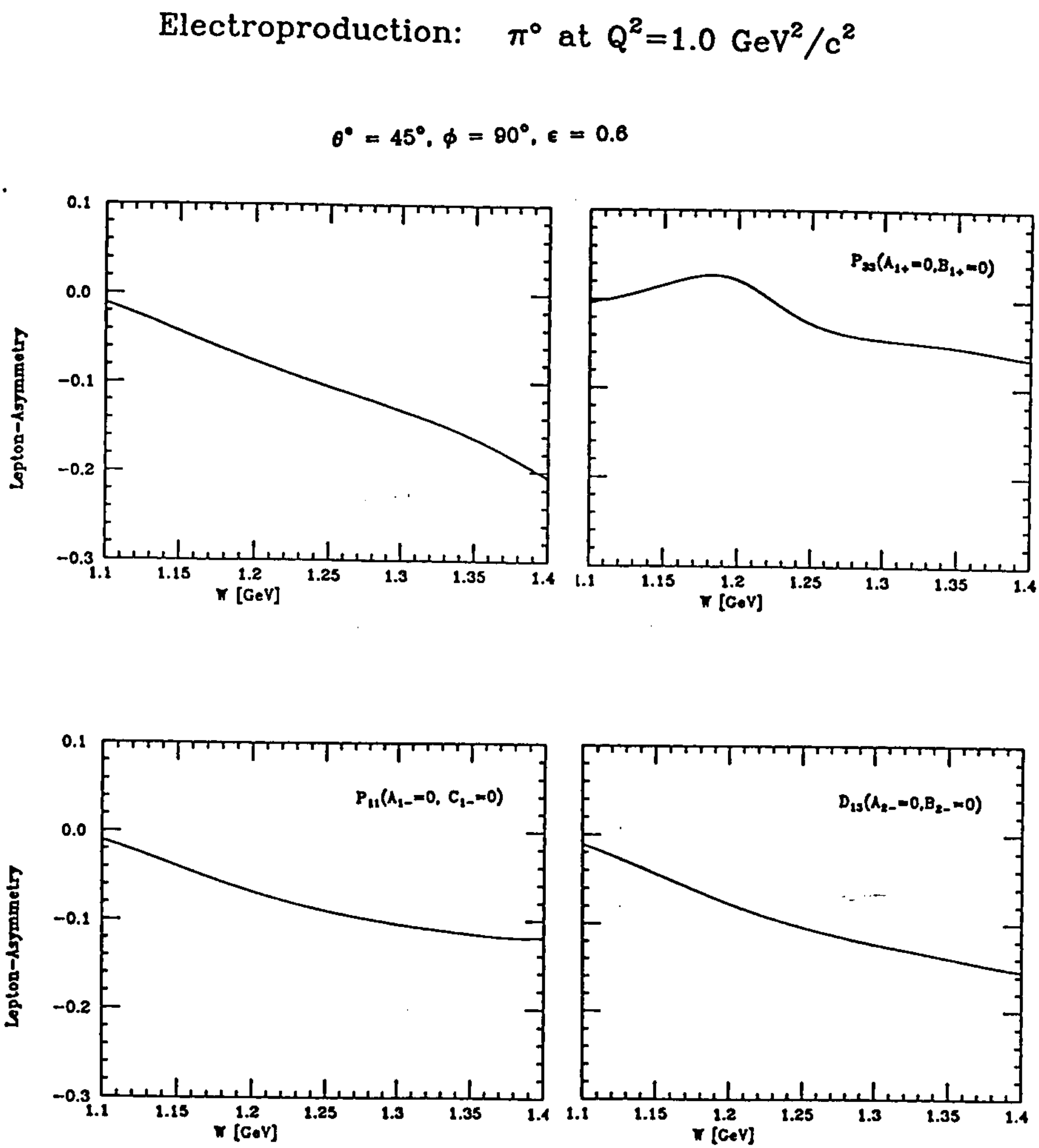

Figure 2. Sensitivity of the lepton asymmetry for π^0 production to resonant amplitudes from various resonances.

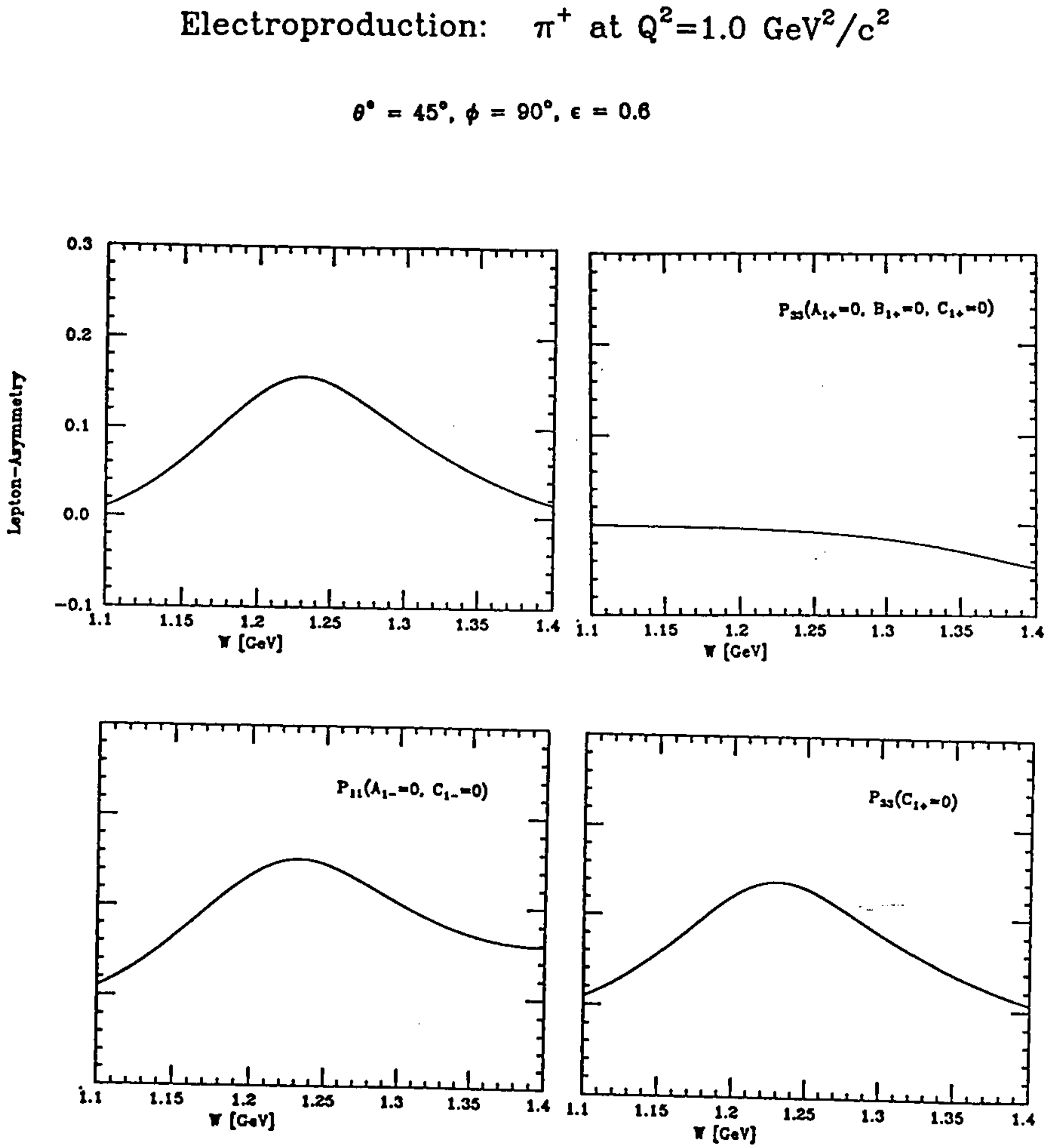

Figure 4. Sensitivity of the lepton asymmetry A_e for π^+ production to resonant amplitudes from the $\Delta(1232)$ and $P_{11}(1440)$.

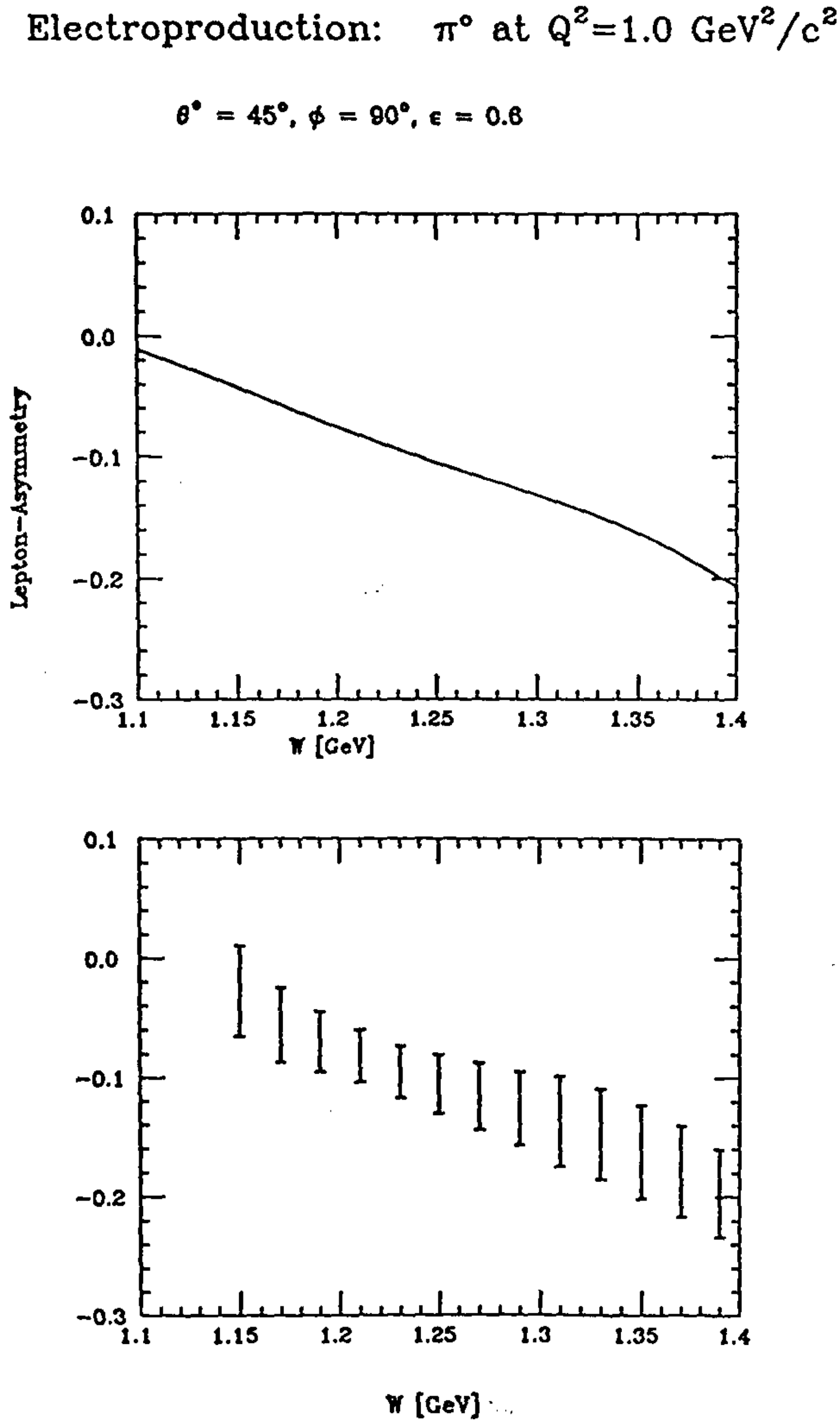

Figure 6. Expected accuracy of the lepton asymmetry for π^0 production versus W.

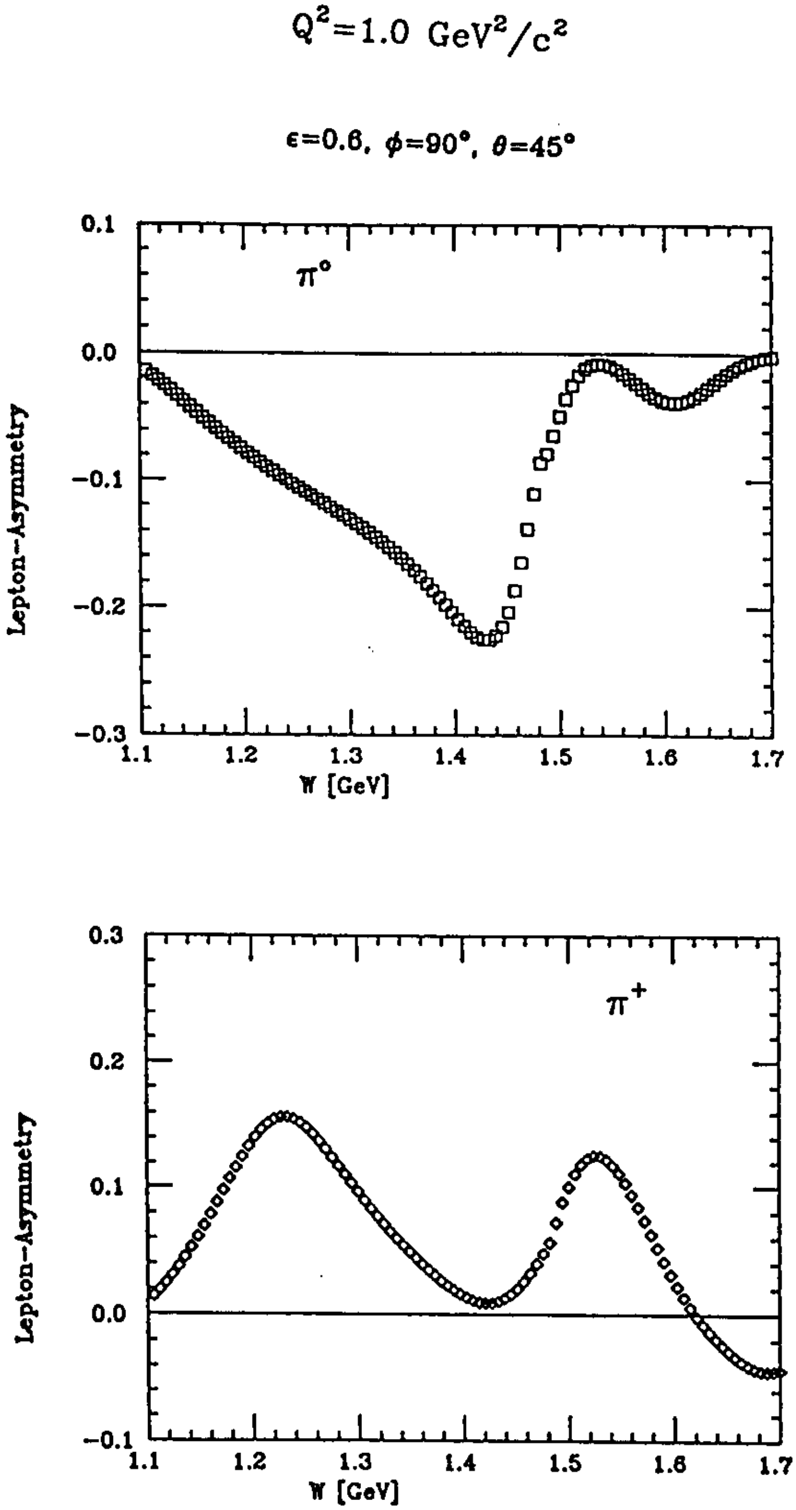

Figure 8. A_e at higher masses, as predicted by the analysis of Boden & Kroesen.