PROPOSED CHARM STUDIES AT SLAC

P. BOSTED

APRIL 2000

- A-DEPENDENCE OF ψ AND ψ' PHOTOPRODUCTION. ALSO, (z_h, p_T) DEPENDENCE FOR LIGHT NUCLEI
  E_γ = 15, 25, 35 GeV

- POLARIZED PHOTON BEAM PLUS POLARIZED TARGET. ACCESS TO

→ $\vec{\gamma}\vec{N} \to \psi X$

→ $\vec{\gamma}\vec{N} \to D_0 X$

A-DEPENDENCE Υ AND Υ' PHOTOPRODUCTION

- Υ' THRESHOLD 11 GeV: HARD AT JLAB:
  NEED HALL D TO GET $\gamma > 11$ GeV?

- SLAC ADVANTAGE HIGHER ENERGY (BUT POOR DUTY FACTOR).

- POSSIBLE EXPERIMENT
  - MEASURE AT $E_\gamma \sim 15, 25, 35$ GeV TO VARY FORMATION LENGTH ($\propto \nu$)
    $\Rightarrow$ EXTRAPOLATE TO Υ, Υ' COMPLETELY FORMED IN NUCLEUS
  - TARGETS: H, Be, Al, TA
    $\Rightarrow$ LOOK FOR CONSISTENCY VRS A
    (PREVIOUS EXPER. HAD ONLY Be, Ta)
  - BEAM: COHERENT BREMSTAHLUNG
    $\Rightarrow$ ALLOWS SEPARATION OF QUASI-ELASTIC AND INELASTIC.

- DETECTION: e^+/e^- or μ^+/μ^-

  BR 7% for Ψ, 0.8% FOR Ψ'

  LARGE DIPOLE (CLAS MAGNET)

  USED TO REDUCE BACKGROUNDS

  ESTIMATE 10% TO 20% EFFICIENCY

- COUNT RATE: IN 2 MONTH RUN

  CAN GET ~ 20,000 J/Ψ PER E, A POINT

  ∴ 200 Ψ' EVENTS " "

  USING $A_{EFF}/A = 1 - \frac{9}{16\pi} \sigma_{\Psi N} A^{4/3} / \pi r_A^2$

	PREDICTION	EXP. ERROR
$\sigma_{\Psi N}$	3-7 mb	<.2 mb (STAT) .5 mb (SYST)
$\sigma_{\Psi' N}$	20 mb	1 mb (STAT) 1 mb (SYST)

- SYSTEMATICS CAN BE TROUBLESOME. AT SLAC

  FOUND CORRECTIONS TO $\sigma(Ta)/\sigma(Be)$

  1) COHERENT PRODUCTION .967

     ⇒ GOOD TO MEASURE AT JLAB

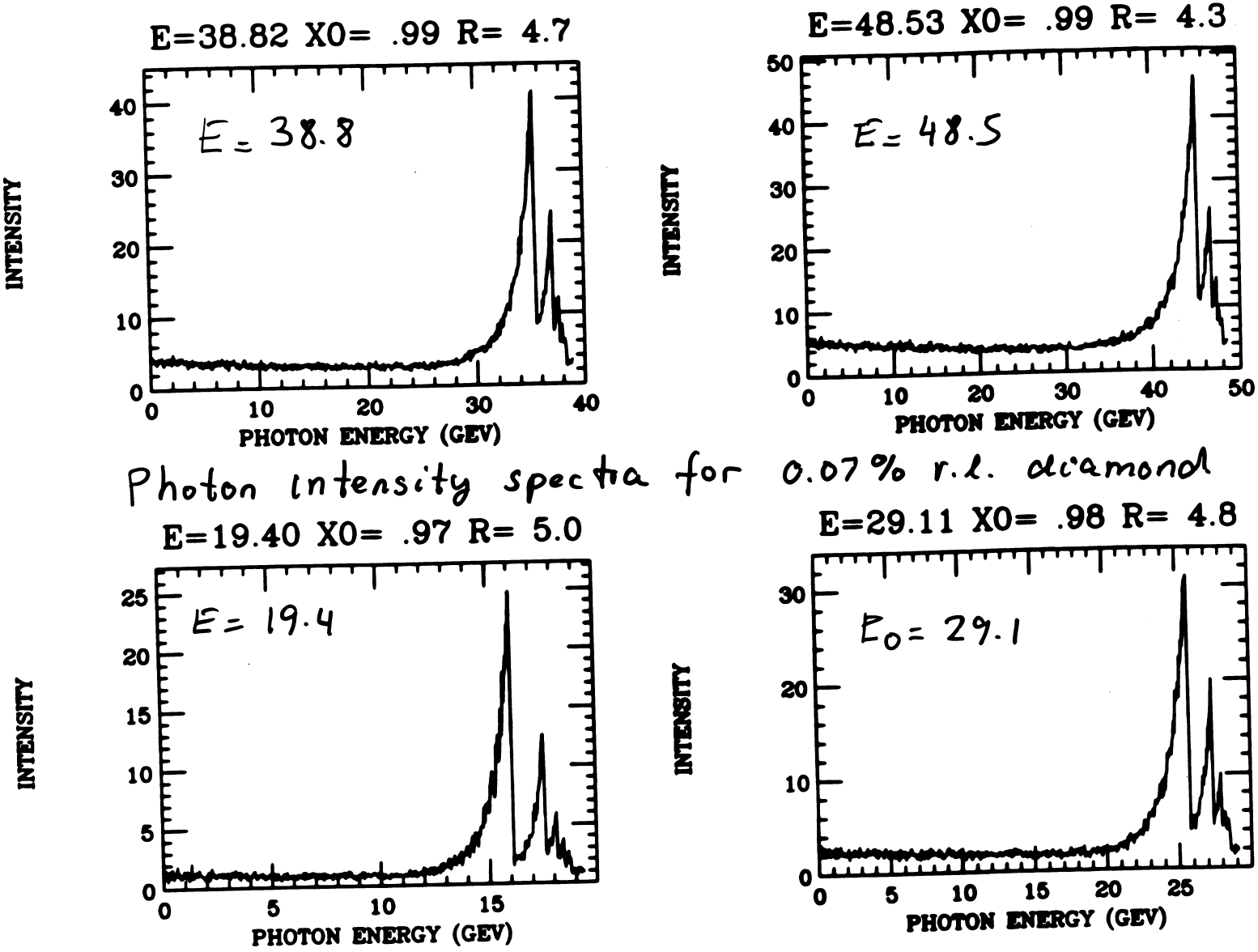
  2) PAULI EXCLUSION EFFECT 0.95

  3) FERMI MOTION 1.06

⇒ NEED GOOD NUCLEAR MODELING!

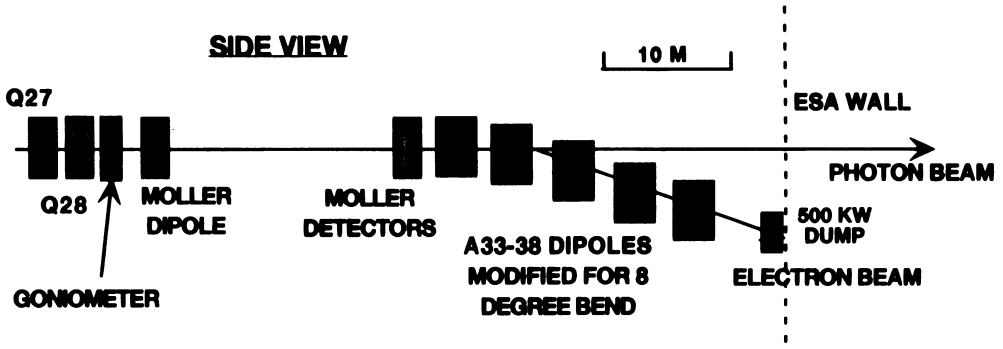
THE PHOTON BEAM

- Coherent bremsstrahlung found to give much better performance than other methods studied: bremsstrahlung difference (subtraction two big numbers to get a small one); backscattered laser beam (rate too low); or photon tagging (duty cycle at SLAC too low).
- Intensity has coherent and incoherent components that can be accurately calculated.
- Use tight collimation to reduce low energy coherent tails.
- Fold in multiple scattering and beam emittance.using Monte Carlo simulation
- Calculation checked by Yerevan group (experts in this field).
- Used previously at SLAC (E78...)

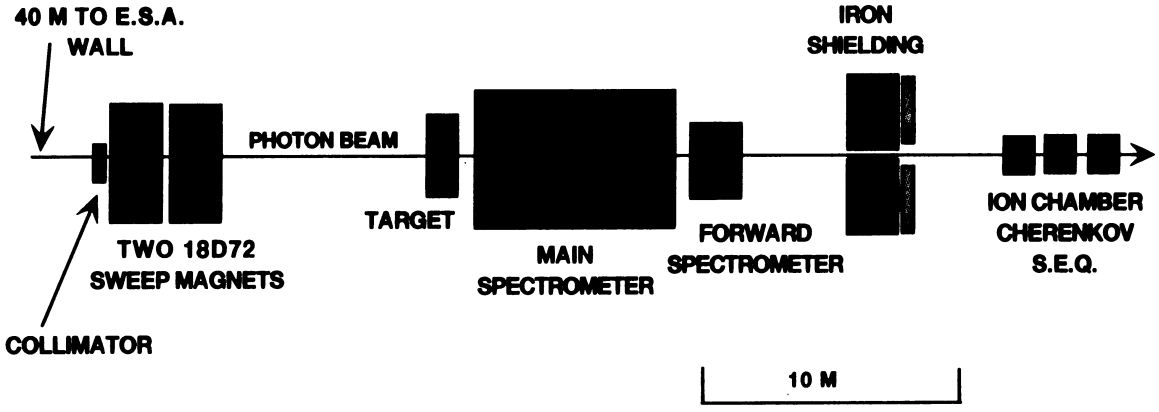

E=38.82 X0= .99 R= 4.7
E= 38.8
INTENSITY
PHOTON ENERGY (GEV)
E=48.53 X0= .99 R= 4.3
E= 48.5
INTENSITY
PHOTON ENERGY (GEV)
Photon intensity spectra for 0.07% r.l. diamond
E=19.40 X0= .97 R= 5.0
E= 19.4
INTENSITY
PHOTON ENERGY (GEV)
E=29.11 X0= .98 R= 4.8
E0= 29.1
INTENSITY
PHOTON ENERGY (GEV)

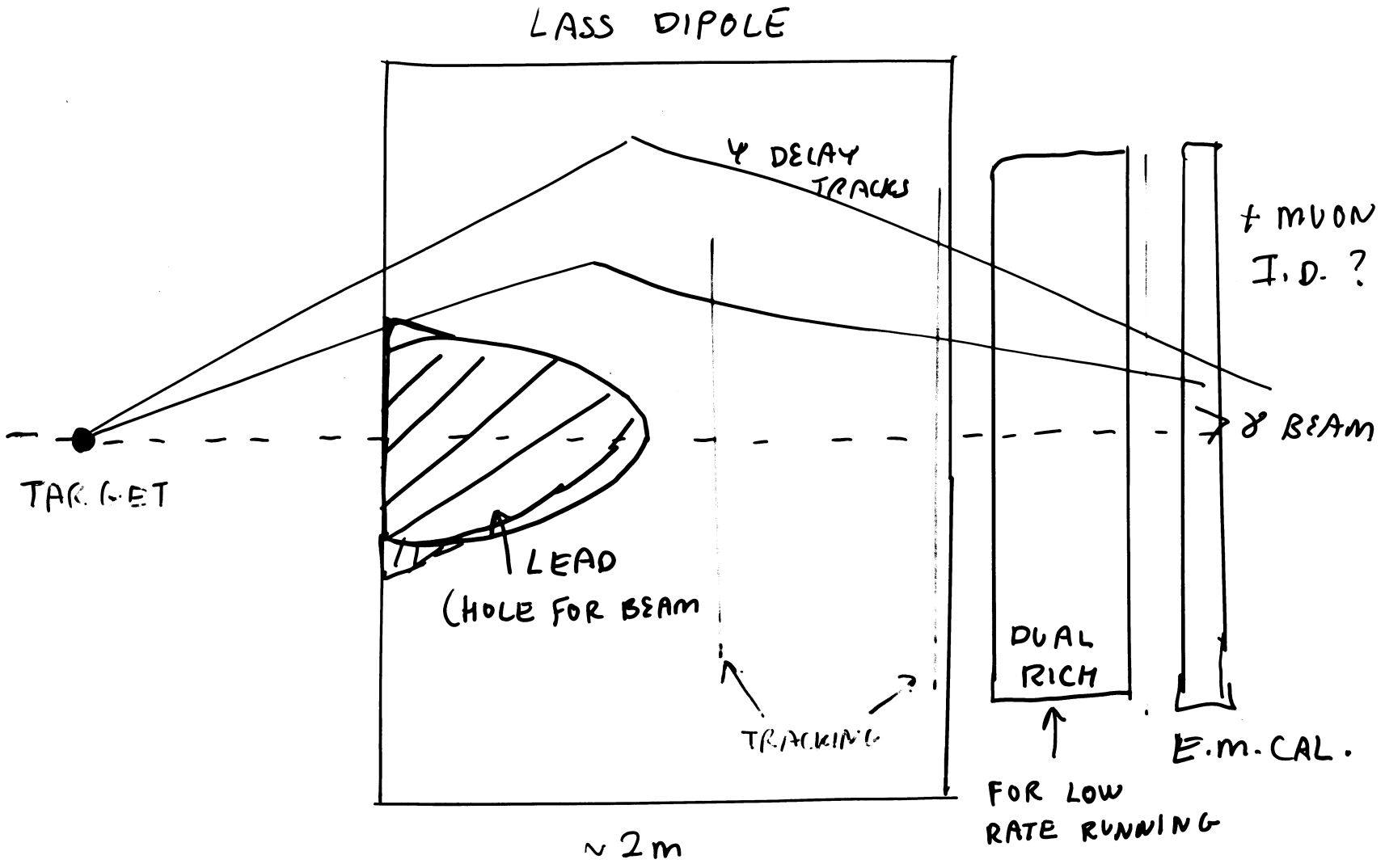
BEAM-LINE LAYOUT FOR E156

SECTION UP-BEAM FROM END STATION A

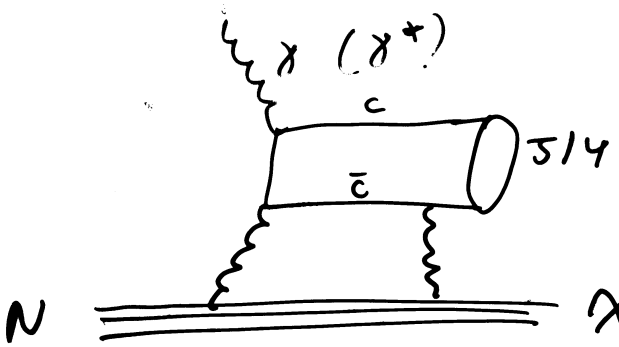


PHOTON BEAM IN END STATION A




LASS DIPOLE
ψ DELAY TRACKS
+ MUON I.D. ?
γ BEAM
TARGET
LEAD
(HOLE FOR BEAM
TRACKING
DUAL RICH
E.M. CAL.
FOR LOW RATE RUNNING
~2m

POLARIZED PHOTO (ELECTRO) -PRODUCTION OF J/ψ ($c\bar{c}$)



COLOR SINGLET MODEL DESCRIBES SPIN-AVERAGED DATA if

- $z < 0.9$ (i.e. inelastic)
- $P_t^2 > 0.5$ (J/ψ moving away from target fast enough)

$$\text{Asymmetry} = \frac{N^{\uparrow\uparrow} - N^{\uparrow\downarrow}}{N^{\uparrow\uparrow} + N^{\uparrow\downarrow}} \propto \frac{\Delta G}{G} \cdot f(a, E, z)$$

$\uparrow\uparrow$ ($\uparrow\downarrow$) means Photon-Nucleon spin aligned (anti-aligned)

Problems

- small cross section (30x less than open charm)
- Theoretical description of $c\bar{c}$ bound state (non-perturbative)
- Accounting for 2nd (soft) gluon

Advantages

- ψ/J easily identified through 7% B.R. to e^+e^- or $\mu^+\mu^-$
- Direct access to vertex kinematics

EXPERIMENT

- E_γ AS HIGH AS POSSIBLE ($\sim$ 40 GeV) $P_B \cdot 0.8$
- 10 cm. LiD TARGET ($\sim$40% OF NUCLEONS POLARIZED, $P \sim 0.7$)
- $\psi \to e^+/e^-$ OR μ^+/μ^- USING SAME DETECTOR AS FOR A- DEPENDENCE
- EXPECT ABOUT 10^5 RECONSTRUCTED ψ's AFTER (z, p_T) CUTS
  $\Rightarrow \delta A \sim 0.01$ (STAT.)

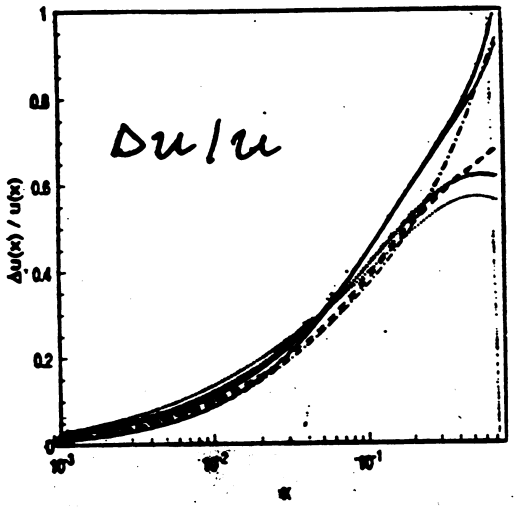
$\Rightarrow$ CAN DISTINGUISH VARIOUS MODELS ($A_{predicted} = 0$ TO 0.2)

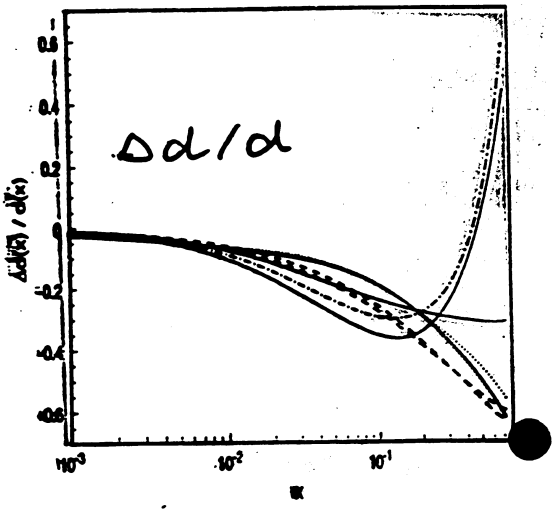
CHECKS: HOW DOES A VARY WITH z AND p_T CUTS?)

[ALSO WILL IMPROVE KNOWLEDGE OF UNPOLARIZED $\sigma(z, p_T)$ BY $\sim$ FACTOR OF 100 AT $\gamma = 40$ GeV]

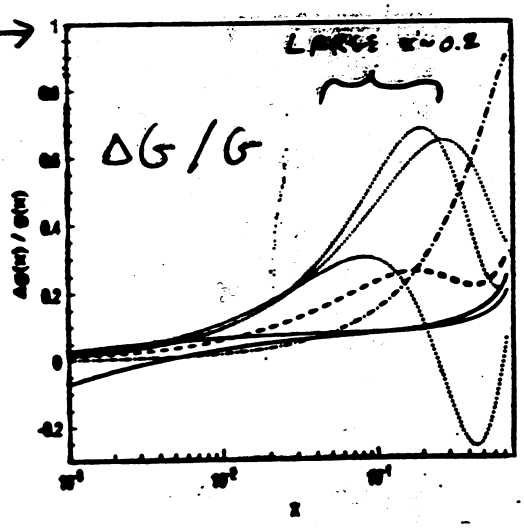
COLLECTION OF POLARIZED PARTON DENSITIES

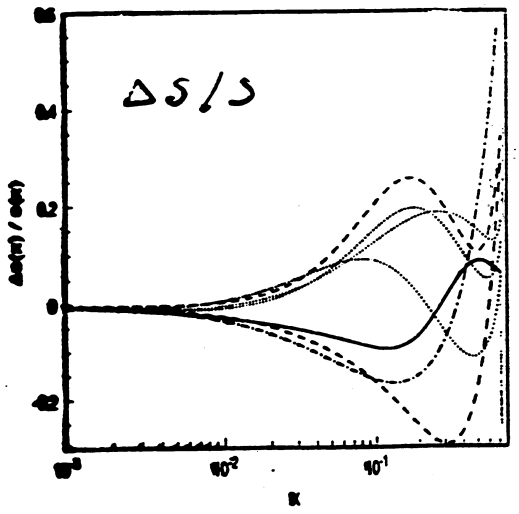
(G.A. LADINSKY - MSU 5112C 1996)





LIMIT! →





OPEN CHARM CROSS SECTIONS

- ALMOST NOT KNOWN FOR $\gamma < 50$ GeV
- MEASURE DIFFERENT CHANNELS

  $\gamma N \to \Lambda_c^+ \bar{D}^0$ (THRESHOLD 8.2 GeV)

  $\to \bar{D}^0 D_0 p$ (THRESHOLD 11.1)

  $\Rightarrow$ DOMINATES HIGH ENERGY

  $\Rightarrow$ E-DEPENDENCE ??

- DETECTION: $D^0 \to K\pi$ CLEANEST

  VERTEX DETECTOR POSSIBLE?

- BEAM: LOW INTENSITY $\sim 10^5 \gamma$/SPILL OR

  10^7/SEC. POSSIBLY LASER

  BACKSCATTERING OR COH. BREM.

- AT 15 GeV, RATE $\sim$ 10,000 / MONTH

  40 GeV, RATE $\sim$ 50,000 / MONTH

  $\Rightarrow$ FACTOR 100 x FERMILAB E687

  EXPERIMENT (SILICON CHAMBERS)

(NOTE: THIS FOR $(K_1 \pi)$ ONLY $\to$ COULD BE HIGHER WITH VERTEX DETECTOR: GLAST TEST ENCOURAGING)

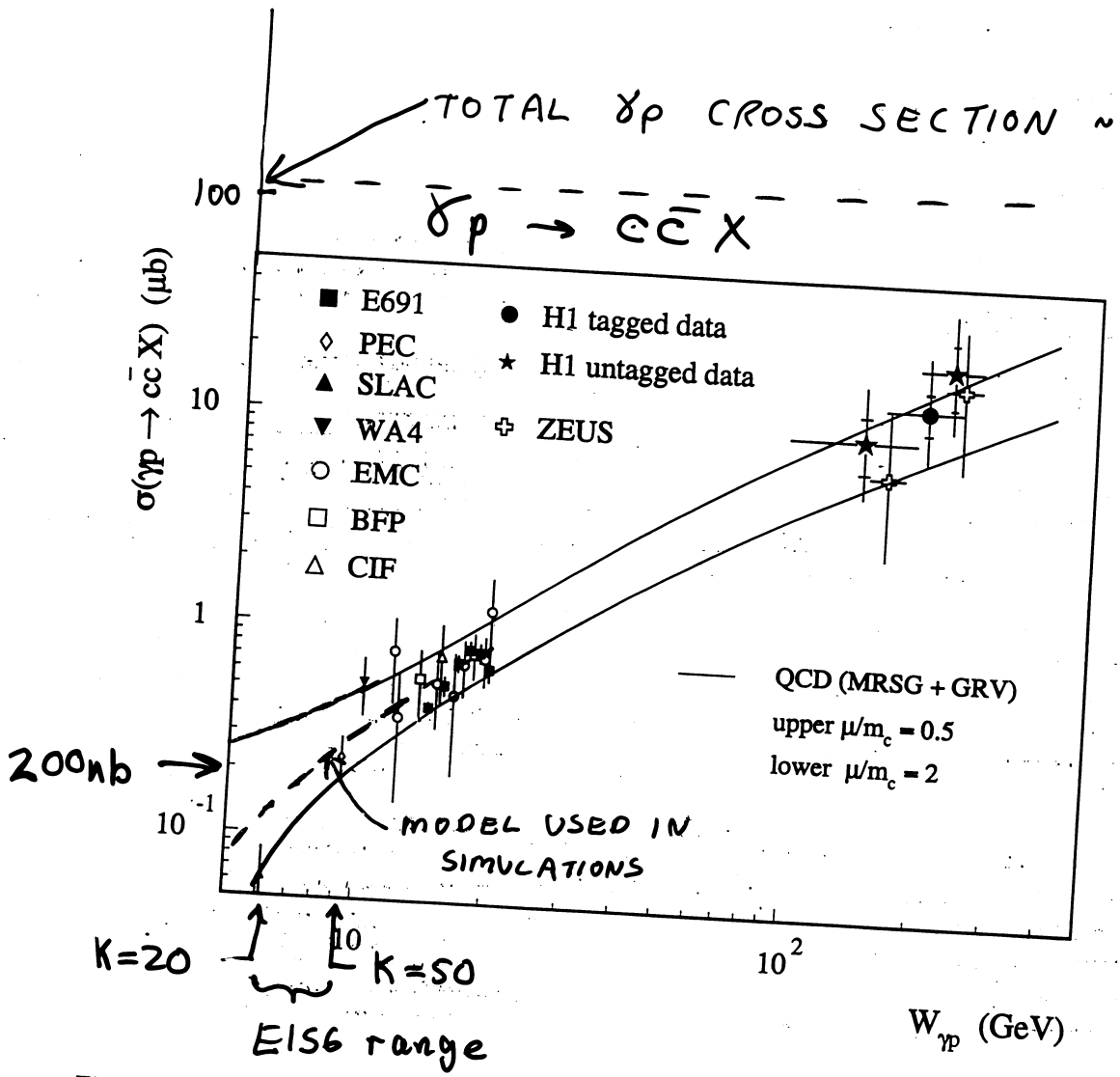


Figure 2: Total charm photoproduction cross section as a function of $W_{\gamma p}$. The solid dots and stars represent the present analyses with statistical and systematic errors added in quadrature (inner error bars). The outer error bars indicate the total error if in addition the uncertainty due to the choice of parton density parametrizations is added in quadrature. The crosses refer to the results of the ZEUS collaboration, the other symbols indicate earlier measurements at fixed-target experiments. The solid lines represent the prediction of a NLO QCD calculation using the MRSG and GRV-G HO parametrizations of the proton and photon parton densities, respectively. The upper and lower lines delimit the range of values expected from varying the renormalization scale within $0.5 < \mu/m_c < 2$.

POLARIZED OPEN CHARM PHOTOPRODUCTION

GOAL: ACCESS $\Delta G/G$ at $x \sim 0.2$ THROUGH DOMINANCE γg FUSION AT HIGH E

BEAM: COHERENT BREM. WITH PEAK NEAR 40 GeV. ~80% LONG. POL.

TARGET: L.H.D. 60% POLARIZATION, $f \sim 0.4$
10 CM. LONG (0.06 r.l.)

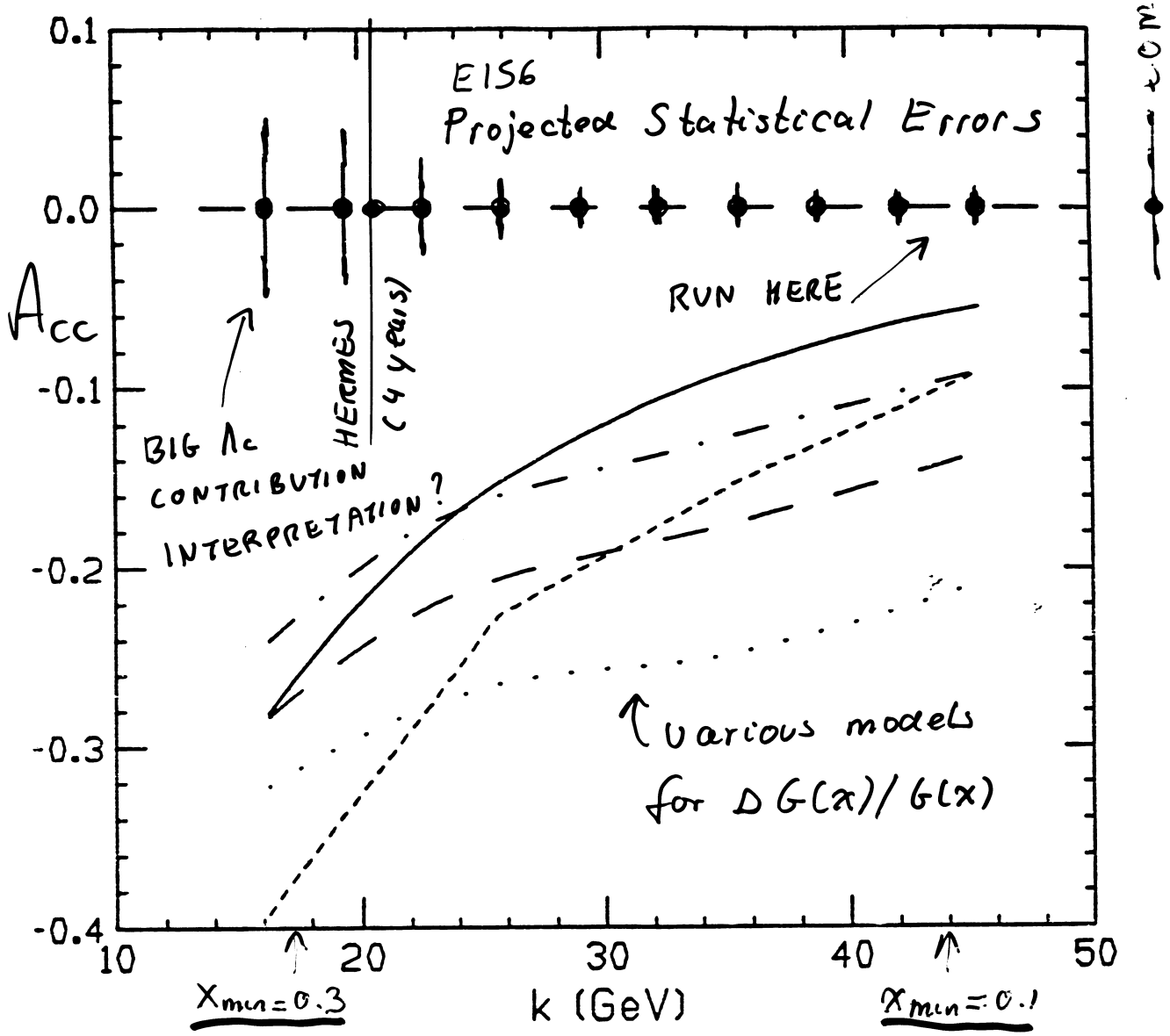
DETECTOR I) BIG DIPOLE: LOOK FOR $D^0 \to K\pi$, OTHER 2 or 3 BODY DECAYS

II) HIGH P_T MUONS THAT DON'T COME FROM J/ψ (VETO THESE)
↳ HIGHER RATE, BUT LESS ACCESS TO $(\hat{s}, \hat{t})$ AT SUBPROCESS

RATE EXPECT $\sim 10^5$ TO 10^6 EVENTS IN TWO MONTH RUN $\Rightarrow \delta A_{cc} \sim 0.01$

PREDICTIONS: $A_{cc} \sim 0$ TO 0.2

Polarized Open Charm Asymmetries



Systematic errors: larger of (~ 0.01, $A_{cc} \cdot 0.06$)

$\therefore$ Experiment has very small projected errors, allowing measurement of both <u>shape</u> and <u>magnitude</u> of $\Delta G/G$

- COMPLEMENTRY TO RHIC (6000 $x_g < .1$)

SUMMARY

INTERESTING PROGRAM, COMPLEMENTRY TO JLAB, IS POSSIBLE $12 < E_\gamma < 50$ GeV

- Ψ, Ψ' CROSS SECTIONS, A-DEPENDENCE
- $D\Lambda$, $D\bar{D}$ CROSS SECTIONS
- POLARIZED BEAM AND TARGETS

$\Rightarrow$ INFORMATION ON ΔG

P.S. THINGS THAT ARE HARD AT SLAC.

I) MEASURING NUCLEAR ELASTIC $-$ USE t dist. ?

II) USING VERTEX DETECTOR AS DONE AT FERMILAB

III) MULTI (>2)-BODY FINAL STATES (I.E. TAGGING $D_c^* \to \pi D_c$)

TO LOOK AT

LINEAR POL. PHOTONS (EASY W/ COH. BREM)

POL. OF J/ψ

t RESOLUTION ?