E161 2 $\mu$ OPTION

- REMINDER OF EXPERIMENT
- 1 MUON PROBLEMS
- 2 MUON RATES, RANDOMS ETC.
HOW TO MEASURE $\Delta g(x, Q^2)$ DIRECTLY

POLARIZED PHOTON BEAM

POLARIZED LiD TARGET

PHOTON-GLUON FUSION ($\sim 10^{-3}\sigma_{\text{tot}}$)

\[ c \rightarrow D \rightarrow \mu \text{ (prompt)} \]
\[ c \rightarrow D \rightarrow K \rightarrow \mu \text{ (delayed)} \]
# PROPOSAL BEAM PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>45.1</th>
<th>48.3</th>
<th>51.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electron Energy (GeV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electron Current ($10^{10}$/spill)</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Peak Photon Energy (GeV)</td>
<td>35.0</td>
<td>40.0</td>
<td>45.0</td>
</tr>
<tr>
<td>Photons ($10^7$/spill)</td>
<td>2</td>
<td>1.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Circular Polarization</td>
<td>0.75</td>
<td>0.80</td>
<td>0.84</td>
</tr>
<tr>
<td>$x_{min}$</td>
<td>0.10</td>
<td>0.12</td>
<td>0.14</td>
</tr>
<tr>
<td>$\mu$/day($p_t &gt; .5$; $P &gt; 5$)</td>
<td>160,000</td>
<td>140,000</td>
<td>120,000</td>
</tr>
<tr>
<td>$\mu$/spill($p_t &gt; .5$; $P &gt; 5$)</td>
<td>0.019</td>
<td>0.016</td>
<td>0.014</td>
</tr>
<tr>
<td>days (at 120 Hz, 100% efficiency)</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

** Use 48.3 GeV, Different Diamond Orientation

♥ E158 had $3.5 \times 10^{11}$ $e^-$ at 48 GeV, 250 ns spill
NUMBER OF EXPECTED SINGLE $\mu$

SIGNAL and BACKGROUNDS

BEFORE BACKGROUND SUBTRACTION
SIGNAL/BACKGROUND

BEFORE DECAY SUBTRACTION

K=35 GeV

K=40 GeV

10<P_{\mu}<15

K=45 GeV

K=35 GeV

K=40 GeV

5<P_{\mu}<10

K=45 GeV

SIGNAL/BACKGROUND

P_{T} (GeV)
NORMAL MODE

SPECTROMETER
EXPECTED RESULTS
BY KINEMATICS

K = 35 GeV
K = 40 GeV
K = 45 GeV

10 < P_\mu < 15

K = 35 GeV
K = 40 GeV
K = 45 GeV

5 < P_\mu < 10

P_T (GeV)

ASYMMETRY

0.6 0.8 1.0 1.2 1.4
0.6 0.8 1.0 1.2 1.4
0.6 0.8 1.0 1.2 1.4
OPEN CHARM
  • DETECT SINGLE MUON
  • ORIGINAL PROPOSAL
  • VERY LOOSE CONSTRAINTS ON $c\bar{c}$ KINEMATICS
  • BACKGROUND: B-H, $\mu$ FROM $\pi$ and K DECAY
  • MORE DIFFICULT THAN ANTICIPATED

OPEN CHARM
  • DETECT 2 $\mu$ FROM CHARM DECAY
  • SMALLER RATES?
  • SMALLER BACKGROUND?
  • SOMewhat BETTER KINEMATICAL CONSTRAINTS ON $c\bar{c}$
  • NO SEPARATE LOW ABSORBER RUN
LOWER RATES
  • BRANCHING RATIO
  • CUTS ON MINIMUM $P_T$ and $P$

COMPENSATE WITH
  • HIGHER BEAM CURRENT
  • THICKER DIAMOND
  • LOWER $P_T$ and $P$ CUTS

LOOSE 2 GeV/c in ABSORBER
  • MINIMUM $P \sim 2.6$ GeV
  • $P_T > .4?$ (backgrounds)

PAIR BACKGROUNDs
  • Bethe-Heitler ($(E_1+E_2) \sim E_{\text{beam}}$)
  • VECTOR MESON DECAY ($W^2 < 1$)

RANDOM COINCIDENCES FROM SINGLES
  • TIGHT COINCIDENCE TIMING
  • EASY SUBTRACTION UNDER PEAK
  • KINEMATIC SELECTION
MONTE CARLO SIMULATION

• HERWIG 6.4
  • INCLUDE INERACTION OF UNDERLYING EVENT
  • MONOENERGETIC $E_\gamma = 45$ GeV
    → WILL DO BREMSTRULUNG SUBTRACTION
  • PROTON TARGET (NEUTRON SIMILAR)
  • PRODUCES $D_s^- > D_s^+$
FRACTION 2 mu/ 1 mu with E>2.6 GeV
FRACTION 2 $\mu[E>2.6]$ / 1 $\mu[E>5]$

- $1 \mu, P_T > 0.5$
- $1 \mu, P_T > 0.7$

$P_T^\mu$ (2$\mu$) MINIMUM (GeV)
2 mu, pt>.4 vs E_{min}
## TIME RESOLUTION
(Real Photon Collaboration Technical Note RPC-1)

<table>
<thead>
<tr>
<th>TDC LSB</th>
<th>PULSE RESOLUTION sigma (ns)</th>
<th>HITS per TRACK</th>
<th>TRACK RESOLUTION sigma (ns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5</td>
<td>.2</td>
<td>1</td>
<td>.32</td>
</tr>
<tr>
<td>.5</td>
<td>.3</td>
<td>1</td>
<td>.39</td>
</tr>
<tr>
<td>.5</td>
<td>.4</td>
<td>1</td>
<td>.47</td>
</tr>
<tr>
<td>1.0</td>
<td>.2</td>
<td>1</td>
<td>.54</td>
</tr>
<tr>
<td>1.0</td>
<td>.3</td>
<td>1</td>
<td>.59</td>
</tr>
<tr>
<td>1.0</td>
<td>.4</td>
<td>1</td>
<td>.65</td>
</tr>
<tr>
<td>.5</td>
<td>.2</td>
<td>5</td>
<td>.15</td>
</tr>
<tr>
<td>.5</td>
<td>.3</td>
<td>5</td>
<td>.18</td>
</tr>
<tr>
<td>.5</td>
<td>.4</td>
<td>5</td>
<td>.21</td>
</tr>
<tr>
<td>1.0</td>
<td>.2</td>
<td>5</td>
<td>.24</td>
</tr>
<tr>
<td>1.0</td>
<td>.3</td>
<td>5</td>
<td>.26</td>
</tr>
<tr>
<td>1.0</td>
<td>.4</td>
<td>5</td>
<td>.29</td>
</tr>
</tbody>
</table>

Table 1: Table 1. Summary of Time resolution dependence on TDC LSB (Least Significant Bit), Pulse Resolution(sigma) and number of hits on a track.

**IF \( \sigma \sim 0.2 \text{ ns}, \Rightarrow \)**

**FULL WIDTH = \( \pm 3\sigma = 1.2 \text{ ns} \)**
UNLIKE SIGN RANDOM COINCIDENCES

TOTAL MUON SINGLES

1.5 ns TIME WINDOW

2.0 ns

2.5 ns
## EXPERIMENTAL RATES

<table>
<thead>
<tr>
<th></th>
<th>E161 PROPOSAL</th>
<th>E161 POSSIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 mu</td>
<td>1 mu</td>
</tr>
<tr>
<td>radiator</td>
<td>.07%</td>
<td>1.5%</td>
</tr>
<tr>
<td>e-beam/spill</td>
<td>2E10</td>
<td>5E10</td>
</tr>
<tr>
<td>photons(top 10%)</td>
<td>1.5E7</td>
<td>1E9</td>
</tr>
</tbody>
</table>

|                  |              |               |               |
| single mu/spill  | 0.020        | 1.3           |
| (Pt>0.5 ; P>5)   |               |               |
| single mu/spill  | 0.010        | .7            |
| (Pt>0.7 ; P>5)   |               |               |
| mu/spill        | 0.034        | 2.2           | 0.024         | .013          |
| (Pt>0.5 ; P>3)   |               |               |
| mu/spill        |               | 1.5           | 0.011         | .006          |
| (Pt>0.6 ; P>3)   |               |               |
| 2(tot)          |               | .009          |
| 3(tot)          |               | .026          |
| 4(tot)          |               | .038          |
| 6               |               | .09           |
REQUIREMENTS FOR EXPERIMENT

• 2 μ
  • ACCEPTANCE AND RESOLUTION FOR $P_T > .5$, $P > 3$
  • EXCELLENT TIME RESOLUTION
  • LOW BACKGROUND SINGLES RATES

• REDUCE SINGLES RATES
  • B-H BACKGROUND
    → MEASURE BOTH $\mu$
    → CUT ON $E_1 + E_2 \sim E_\gamma$
    → DO BREMS SUBTRACTION
  • LOW $\mu$ RATE FROM K $\pi$ DECAY
OTHER SCHEMES

• COINCIDENCE BETWEEN
  \[ c \rightarrow D \rightarrow \mu \]
  \[ c \rightarrow \bar{D} \rightarrow \bar{K} \rightarrow \bar{\mu} \]

  • LESS ABSORBER BY TARGET FOR K decay
  • SOME OF THIS IN RANDOM BACKGROUND
CONCLUSIONS POSSIBLE

- RANDOMS BIGGEST PROBLEM
- BACKGROUND CLEANLY SUBTRACTED
- NO NEED FOR SECOND ABSORBER SETUP
- NEED OPTIMIZATION OF CUTS
- COULD USE SOME OF BACKGROUND