A PROPOSAL TO STUDY $\nu$ AND $\bar{\nu}$ INTERACTIONS IN GARGAMELLE

WITH A 140 GEV DICHRONOMATIC BEAM

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Bergen - Ecole Polytechnique Collaboration

At the time we submitted proposal 46 the collaborations were left open; these have now been specified \(^{(1)}\). In this Addendum, we want to concentrate more on the 140 GeV Narrow Band Beam proposal.
INTRODUCTION

This experiment intends to use the WANF dichromatic beam with 140 GeV parent energy in Gargamelle to study neutral currents and possible new phenomena. The complete requirement would be 200'000 $\bar{\nu}$ pictures and 400'000 $\nu$ pictures.

I. PHYSICS AIMS

This point has already been discussed in Proposal 46, but we shall recapitulate here what is specific to the 140 GeV NB experiment.

I.1 Neutral Currents

- Total cross sections at fixed energy,
- Differential cross-sections.

The analysis of the $(x,y)$ plot ($x = q^2/2MV$, $y = \nu/E$, $\nu = \text{energy transferred to the hadrons}$) will give important tests on the structure of the neutral current, and relate various models.

- Study of exclusive channels, such as $\bar{\nu}N \rightarrow \bar{\nu}NN$.

We just mention that we see what happens at the vertex, and that this experiment will still be competitive with FNAL experiments.

I.2 New Phenomena in Charged or Neutral Current Events

With the incident energy $\nu_\mu \sim 50$ GeV and $\nu_K \sim 128$ GeV, we can produce particles with masses up to 10 GeV. We can thus expect to be above the threshold of possible new phenomena, such as:

- Production of charmed particles,
- Production of heavy leptons.

This can for example give rise to anomalies in $(x,y)$ plots and/or to multi-lepton production. In the case of di-lepton production ($\mu^-\mu^+$ or $\mu^-e^+$) associated with strange particles, we have the advantage that we are able to see the vertex. At a 1% production rate we expect 85 such events in $\nu$ pictures and 23 events in $\bar{\nu}$ pictures for the total proposed experiment.
II. EXPERIMENTAL CONDITIONS

We want to use the WANF dichromatic beam \(2\) with a parent energy of 140 GeV.

The detector will be Gargamelle filled with a light propane-freon mixture giving a radiation length of ~ 60 cm and a density of 0.5 g/cm\(^3\), in order to combine a good measurability of charged particles and of \(\gamma\)'s from \(\pi^0\)'s. The fiducial volume will be a cylinder of 1 m diameter and 3.6 m long.

The number of charged current events (CC) and neutral current events (NC) are given in Table 1 assuming NC/CC = .22 and .50 respectively for \(\nu\) and \(\bar{\nu}\).

<table>
<thead>
<tr>
<th></th>
<th>E</th>
<th>(\Delta E/E)</th>
<th>Number of events/(10^3)</th>
<th>ppp/(10^4)</th>
<th>pictures</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\nu_{\pi})</td>
<td>48.7</td>
<td>.18</td>
<td>35.9</td>
<td>423</td>
<td>79</td>
</tr>
<tr>
<td>(\nu_{K})</td>
<td>125.5</td>
<td>.10</td>
<td>64</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>(\bar{\nu}_{\pi})</td>
<td>48.2</td>
<td>.19</td>
<td>54.8</td>
<td></td>
<td>27.4</td>
</tr>
<tr>
<td>(\bar{\nu}_{K})</td>
<td>127.3</td>
<td>.06</td>
<td>2.8</td>
<td></td>
<td>1.4</td>
</tr>
</tbody>
</table>

This would give for 200'000 \(\nu\) and 400'000 \(\bar{\nu}\) pictures, a total of 8500 CC and 1900 NC interactions in \(\nu\), and 2300 CC and 1150 NC interactions in \(\bar{\nu}\).
The EMI for Gargamelle is required to enable a clear separation between NC and CC events. If a CC event is identified by requiring that the muon hits both EMI planes, and a NC event is identified by requiring all negative (positive) charged hadrons in \( \nu (\bar{\nu}) \) events to interact in the chamber or to reach the EMI, we have efficiencies as shown in Table 2.

<table>
<thead>
<tr>
<th></th>
<th>CC</th>
<th>NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \nu )</td>
<td>93%</td>
<td>88%</td>
</tr>
<tr>
<td>( \bar{\nu} )</td>
<td>99%</td>
<td>93.5%</td>
</tr>
</tbody>
</table>

This concludes to almost 100% separation in \( \bar{\nu} \) interactions, whilst in \( \nu \) interactions the background is still small and will only be concentrated in specific regions of the \((x,y)\) plot.

II.1 Analysis Power

The groups involved here have both long experience in \( \nu \) physics in Gargamelle and analysis of rather complicated events in a \( p \) experiment also in Gargamelle.

Physicists:

Bergen : A. Haatuf, K. Myklebost, J.M. Olsen
Ecole Polytechnique : B. Degrange, Th. François, M. Haguenauer,
                    U. Nguyen-Khac, A. Rousset.

Measuring Power:

On-line measuring tables

Bergen : 2
Ecole Polytechnique : 5
CONCLUSION

The group would like to start the experiment as soon as possible and asks in the first year for:

Table 3

<table>
<thead>
<tr>
<th>Number of pictures (10^{13} ppp)</th>
<th>CC events</th>
<th>NC events</th>
</tr>
</thead>
<tbody>
<tr>
<td>\nu</td>
<td>100 K</td>
<td>4230</td>
</tr>
<tr>
<td>\bar{\nu}</td>
<td>50 K</td>
<td>288</td>
</tr>
</tbody>
</table>

The 60 and 140 GeV NB collaborations propose to compare their results, which are complementary, after the analysis of the first part of the pictures. After that they will discuss together which is the best way to continue both experiments.
REFERENCES

1. CERN/SPSC/75-74/\{P31/Add 1
    P46/Add 2
    CERN/SPSC/75-71/p53