Letter of intent for an experiment at LEAR

A. S. Clough, University of Surrey; N. M. Stewart, Bedford College, University of London;

D. V. Bugg, J. Chaney and J. A. Edgington, Queen Mary College, University of London.

We intend to submit a proposal to study the two-body channels

$\bar{p}p \rightarrow \bar{p}p$ (1)

$\bar{p}p \rightarrow \pi^+\pi^-$ (2)

$\bar{p}p \rightarrow K^+K^-$ (3)

$\bar{p}p \rightarrow \bar{n}n$ (4)

over the full angular range and the full momentum range available at LEAR, with statistical and systematic errors ranging from 1% per point for reaction (1) up to 5% per point for reaction (4). The experiment falls naturally into three stages.

In the first stage we propose to measure the differential cross section for reactions (1) - (3) in small momentum steps, to look for narrow resonant states. A sketch of the proposed experimental layout is shown in Figure 1. We prefer to use an internal gas jet target, which allows very low energy particles to be detected with ease. Very high counting rates are available from a target of quite modest performance (10^{-11} g cm^{-2}), and the statistical precision we desire should be obtained over the whole angular range in running times of the order of one hour per momentum. With the gas density proposed, and even without electron cooling, beam lifetime is of the order of hours. However, if the gas jet is not available in the early stages of operation of LEAR, it would be possible to make similar but slightly more restricted measurements with a small liquid hydrogen target in the external beam. Whichever is used, we want to make definitive measurements, with small systematic errors, at the first attempt.

The second stage is to measure reaction (4), using either an internal or an external target. The equipment will be reconfigured, the MWPCs being converted to neutron detectors by the addition of passive converters , a technique we have used succesfully at TRIUMF. Some study of the response of these detectors to antineutrons will be necessary.

At the third stage, we propose to use a polarised gas jet, to measure polarisation parameters in reactions (1) - (3), with an accuracy of order 1% - 3% per point. These measurements will necessarily come last, as the polarised gas jet target will not be available initially, also, the kinematic regions to be studied, and the overall motivation for these measurements, will depend upon the results of the first two stages.

We now discuss the motivation for these measurements. Reaction (1) is known to be dominated by diffraction. This implies that most partial waves will be imaginary, and with a magnitude close to the centre of the Argand diagram. Resonant states (e.g. baryonium) are then to be observed by interference with the diffractive background. Resonant states of very low elasticity are detectable by virtue of measuring this interference, which depends on the resonant amplitude rather than intensity. In particular one can hope to observe structure in the differential cross section in the forward hemisphere, where counting rates are very high. The T and U resonances were observed this way by Coupland et al[1]. If baryonium exists, it should have a reasonable branching ratio to $\bar{p}p$.

If narrow states are observed, two body channels are likely to be suitable for determining quantum numbers. The $\pi\pi$ channel is strongly restricted by G parity and parity, and helps identify the isospin. Measurements of reaction (4) will, in any case, be necessary in order to disentangle the isospin dependence in the elastic channel, reaction (1).

If narrow states are not observed, it seems likely that the mass range will be rich in broad resonances, and thus definitive measurements leading to an amplitude analysis are likely to be profitable. Eisenhandler et al[2,3,4] measured the differential cross section with high accuracy from 690 to 2430 MeV/c, and polarisation in reactions (2) and (3) above 1 GeV/c, and found three broad resonances[5]. Measurements of greater precision, and at lower momenta, are highly desirable.

The group's present commitments at TRIUMF will be completed by the time LEAR operates, and it is our wish to participate in the early stages of the experimental program at LEAR, in collaboration with other interested groups.

References

1) M. Coupland, E. Eisenhandler, W.R. Gibson, P.I.P. Kalmus and A. Astbury, Phys. Letters 71B (1977) 460
2) E. Eisenhadler et al, Nucl. Phys. B113 (1976) 1
3) E. Eisenhandler et al, Nucl. Phys. B96 (1975) 109
4) A.A. Carter et al, Nucl. Phys. B127 (1977) 202
5) A.A. Carter et al, Phys. Letters 67B (1977) 117

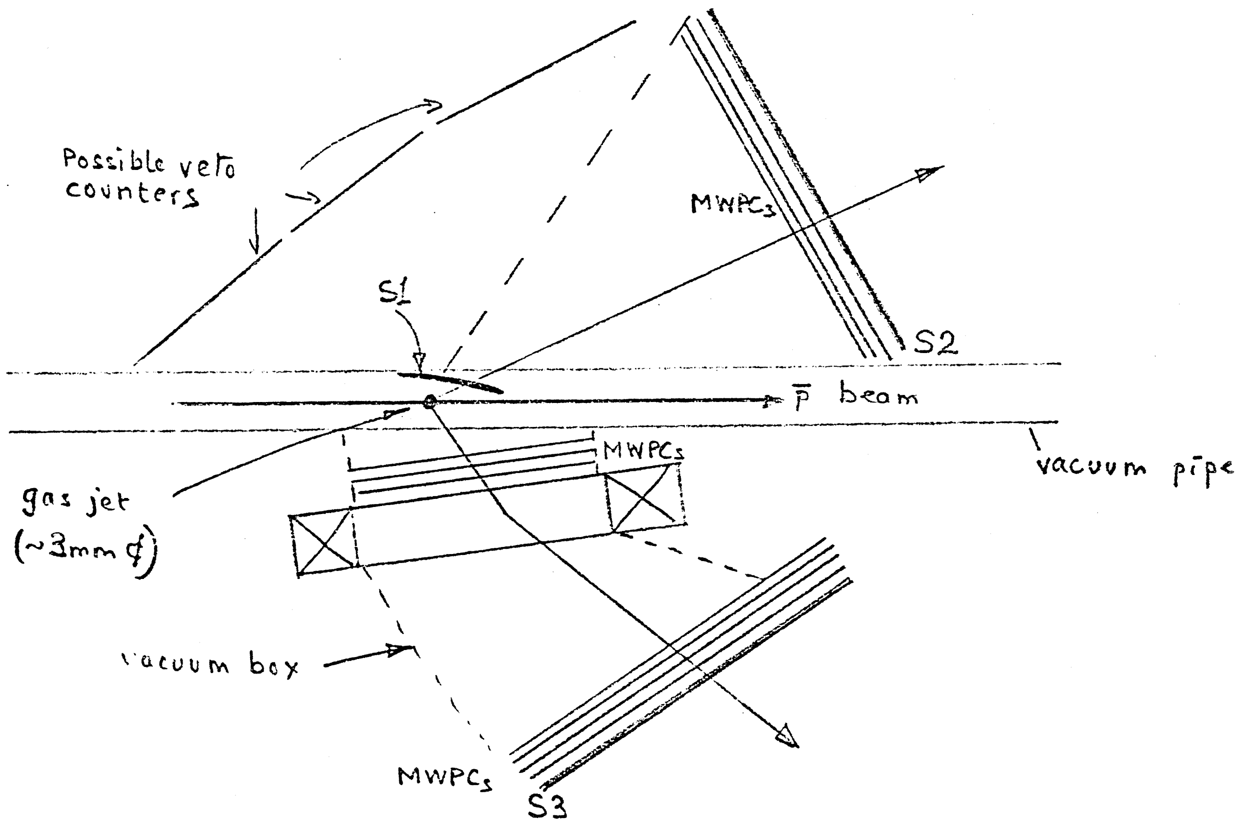

Fig 1. Proposed experimental configuration. Trigger = S1.S2.S3. Times of flight S1 - S2 and S1 - S3 are recorded. Care will be required in the design of the vacuum vessel around the target region, to minimise the thickness traversed by particles.