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LETTER OF INTENT

THE PRODUCTION OF STRANGE BARYONS AND ANTIBARYONS WITH RELATIVISTIC LIGHT IONS COLLISIONS AT THE CERN SPS

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ABSTRACT

We propose to measure the production of strange baryons and antibaryons with light ion collisions over the energy range of 13 GeVA to 200 GeVA at the CERN SPS. A high-field superconducting magnet would be used to disperse the high multiplicity of mesons from the region of our measurement. A micro TPC would be used to recognize primary decay kinks and secondary decay V^o's.

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1. INTRODUCTION AND GOAL

The construction by Lawrence Berkeley Laboratory (LBL) and Gesellschaft für Schwerionenforschung Darmstadt (GSI) of an injector for the CERN SPS opens extraordinary opportunities for the study of high energy nucleus-nucleus collisions. Beam energies up to 225 GeVA will be available.

LBL and GSI are presently approved for an exploratory experiment using a streamer chamber and the plastic ball. The terms of the LBL-GSI-CERN Agreement concerning the ion source include availability of the beam to all comers. Already letters of intent have been submitted by others: other letters of intent and actual proposals are expected soon. We, as the LBL participants in the now-completed ISR Program with light ions, have devised an experiment to measure the production of strange baryons and antibaryons [P, Λ, Σ, Ξ, Ω ($|S|$ = 0, 1, 2, 3)].

A measurement of the strange baryon and antibaryon production has been proposed as a possible signal in recognising whether a quark-gluon-plasma is formed at sufficiently high bombarding energies. For example, a study of strange baryons and antibaryons and the measurement of particle production ratios gives evidence on the relative densities of strange and non-strange quarks and antiquarks in the reaction volume. An example of such ratios is $P:\Sigma:\Xi:\Omega$ which should be a simple sequence corresponding to the composition of those particles: (qqq):(qqs):(qss):(sss). The anti-particle production ratios are expected to be different because while one may expect $\bar{s}$ production to equal s production the number of q (u, d) and $\bar{q}$ quarks in the final state will be different because of the large number of q quarks already present before the collision. Many such ratios have been measured for pp and p-nucleus collisions and several phenomenological models have been devised to explain them. Our experiment would add information for a new range of parameters which will be valuable irrespective of whether a new state of matter is formed.

2. EXPERIMENTAL DESIGN

The detection of strange baryons and antibaryons is complicated by the fact that they have relatively short decay lengths (2.4 cm $\leq c\tau \leq$ 7.9 cm).

This forces a compact experimental design in order to have reasonable efficiencies at the lowest projectile energies (13 GeVA) and even for the highest projectile energies (~ 200 GeVA). We have the additional complication that the events most desirable for study are those with a maximum number of nucleons participating which will have very high multiplicities in the laboratory forward cone.

Although ^{16}O beams are anticipated for 1986 in the SPS, heavier ion beams are expected to follow in the subsequent years. Therefore, we will attempt an experimental design which will accommodate the very high multiplicities expected for the interactions of these heavier ion beams. Not all of the nucleons will participate and therefore we must anticipate a large number of target and projectile fragments which also appear in this laboratory forward cone.

Since the major portion of the high multiplicity is associated with mesons which are light compared to the baryons we will use a magnetic filter to sweep away the lower momenta from the forward cone. In order to achieve a compact design we will use a high-field superconducting magnet to disperse the high multiplicity of mesons, target fragments, and projectile fragments from the region of our measurement. In this relatively particle free region we will place a micro TPC to detect the $B\bar{B}$ production. The μTPC would follow the design of the ALEPH central detector TPC in terms of electronics and sense pad design thus allowing both this effort and ALEPH to benefit from a common set of detector experience. The μTPC would be placed adjacent to the beam and dispersed nuclear projectile fragments. It would only see momenta greater than a determined value in the forward cone. Its geometry would be such as to allow for both recognition of a primary decay kink and a secondary decay V^o. Beyond the μTPC we would place three planes of drift chambers to provide enhanced momentum measurement resolution for the highest projectile energies (~ 200 GeVA). This would be followed by a Cherenkov threshold detector hodoscope. Important supplementary detectors would be a multiplicity detector, beam tag, and projectile (fragment) energy detector.

3. BEAMS AND BEAM LINE

It is our desire (within the constraints of this experiment) to stay compatible with the presently approved LBL-GSI exploratory experiment using a streamer chamber in the SPS West Experimental Area beam H3 and plastic ball in the X5 beam. These beams are designed as test beams for the LEP Detectors (L3 beam X3, OPAL beam X5, DELPHI beam X7A and ALEPH beam X7B). The H3 beam is split three ways between X3, X5, and X7 with a double magnetic split.

In its present form the beam will be shared between the streamer chamber (H3) and the plastic ball (X5) (the top and bottom of the three way split). The remaining middle portion of the beam is sent to X7, the ALEPH test beam. We propose to use this beam, X7, with the permission of ALEPH for the light ion experiment we will propose. We hope to be able to run simultaneous to the experiments in H3 and X5B. These experiments will ask for low energy ≤ 15 GeVA and ≥ 40 GeVA running in 1986. We would request running at 13, 40, 75 GeVA, 200 GeVA with priority in the same order (13 GeVA highest). From the experimental viewpoint starting with lowest energy is easiest since the multiplicities are least and the forward cone opening angle is largest. This would allow us to gain experience in the accommodation problems and thus adapt the detector and detection algorithms for the highest multiplicities at the highest energies.

3.1 Support

The major portion of the support for this experiment is expected to come from LBL including the construction and testing of the detector system. Additional collaborators from CERN Member States and CERN are being considered to bring the final number to about 15 collaborators. The detector and electronics development on TPC done with the ALEPH LEP Collaboration is to be conducted in a mutually beneficial manner resulting in cost savings. Some aspects of the detector development will also take advantage of test beams at SLAC. It is quite clear that the additional support will be needed from CERN in the form of beam lines, accelerators, and the general base required for supporting experiments such as this. Max Plank Inst. München (MPI) has provided both financial support and encouragement in the preparation of this experiment.

3.2 Schedule

It is our expectation to be ready for the lowest energies 13 and 40 GeVA by January 1986 and the higher energies 75 and 200 GeVA for the following year, 1987. Because of the tightness of this schedule we would like to present our proposal for consideration at the earliest time (after 1 March 1984).