Madame Roswitha RAHMY
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50th ANNIVERSARY 1931-1981
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University of California • Berkeley, California 94720

Building 50D

CERN/PSCC/82-9
PSCC/P53 Add. 1
March 26, 1982

Professor P. G. Hansen
Chairman, PSCC Committee
EP Division
CERN
CH 1211 Geneva 23
SWITZERLAND

Dear Dr. Hansen:

Your committee requested clarification about the experimental techniques we intend to use in our proposed experiment with PS oxygen ions. In addition to my presentation scheduled for the 20th April, let me submit today three recent publications: on Λ production observed in the streamer chamber (J. W. Harris, et al., Phys. Rev. Lett. 47 (1981) 229), on the plastic ball spectrometer (A. Baden, et al., submitted to Nucl. Instr. Meth.), and a short conference paper (H. G. Ritter, et al.) about first plastic ball results. This should clarify, in part, our proposed techniques.

About the streamer chamber configuration: we propose to use the SLAC streamer chamber magnet that has been made available to us by Dr. Panowsky. It is a warm Vertex type magnet with 2 m pole diameter and 1 m gap width (see enclosed drawing). At 12 kG the power demand is 3.7 MW. The required voltage is about 550 V; it should therefore run on two of the CERN Oerlikon 600 V power supplies. It is water cooled. The total weight, with a stray field shielding dome accommodating the cameras, is ca. 450 tons. The heaviest component pieces of the magnet weigh ca. 45 tons. With its field dimensions it accommodates the Munich UA5 streamer chamber, in a configuration identical to that in the CERN Vertex magnet. That chamber plus Blumlein and Marx generator is available to us. We will either use the SLAC camera system, or our own present image intensifier cameras. Computer-wise, we will use a PDP 11 on each of the two experiments, coupled to a VAX 11/780 by shared disc.

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Of course, the transportation and installation cost will be high. For the installation, SLAC will permit us to use the engineers that have been in charge of the magnet as consultants. If we should find a cheaper alternative solution for the magnet we would of course switch to that.

Hoping that the enclosed materials are useful, I remain

Sincerely yours,

Reinhard Stock

Reinhard Stock

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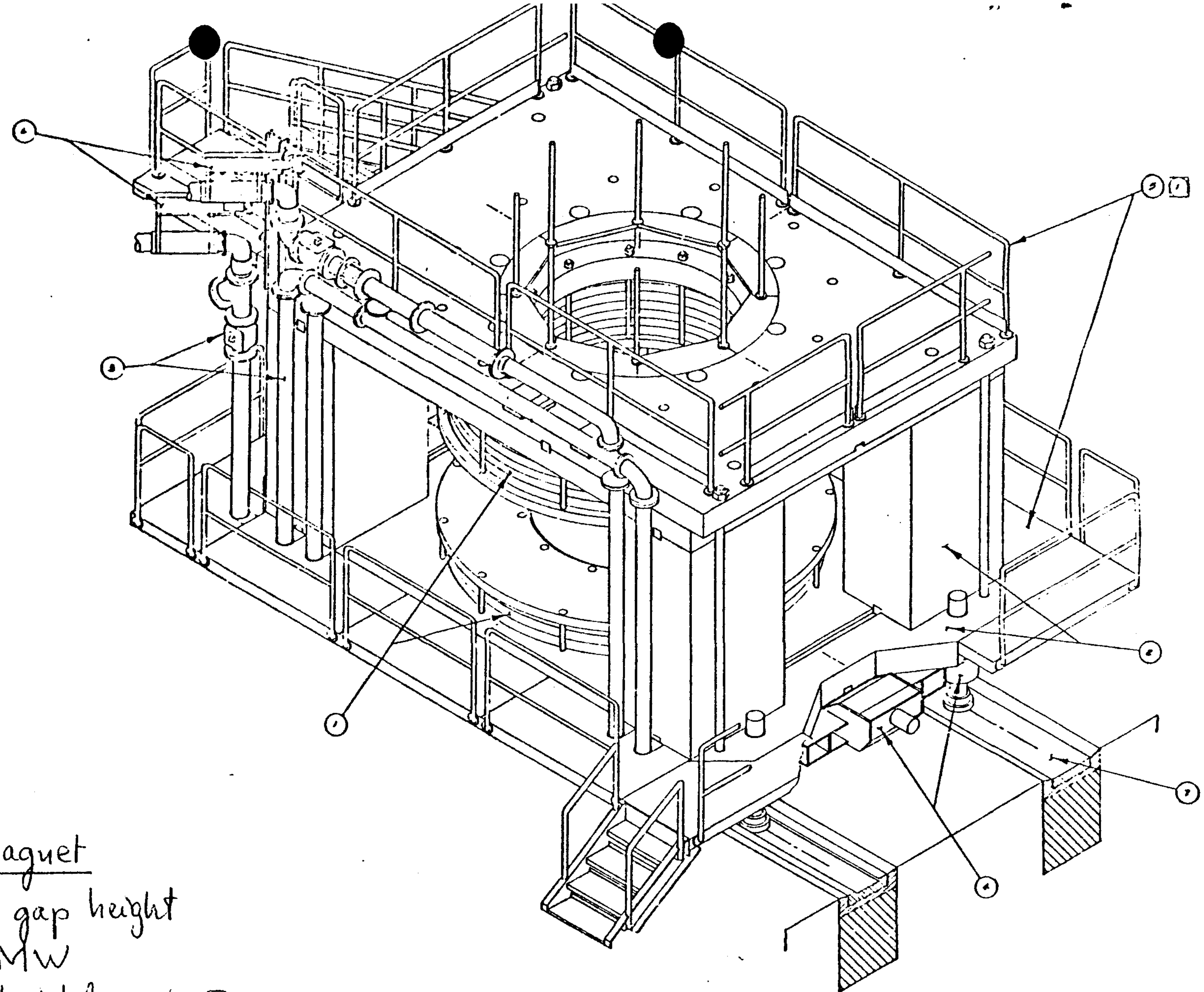
Enclosures



SLAC Vertex Magnet

2m pole ⌀, 1m gap height
12 kG at 3.7 MW
Frame 6 x 4 m^2, height ca. 4.5m

First page only for reference

Λ Production near Threshold in Central Nucleus-Nucleus Collisions

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and

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and

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(Received 23 April 1981)

Λ's produced in central collisions of ^{40}Ar + KCl at 1.8-GeV/u incident energy were detected in a streamer chamber by their charged-particle decay. For central collisions with impact parameters $b < 2.4$ fm the Λ production cross section is 7.6±2.2 mb. A calculation in which Λ production occurs in the early stage of the collision qualitatively reproduces the results but underestimates the transverse momenta. An average Λ polarization of −0.10±0.05 is observed.

PACS numbers: 25.70 Bc

In the study of high-energy nucleus-nucleus collisions it is difficult to extract information about the initial stage of the reaction where high baryon densities may occur. Studies of nucleon and cluster emission[1] are consistent with a development towards chemical equilibrium in the final stages of the reaction preempting information about the primary stages. In this Letter we report the results of Λ production in central nucleus-nucleus collisions, just above the *NN*

First page only for reference

LBL-13620

The Plastic Ball Spectrometer--an Electronic 4π Detector with Particle Identification

A. Baden[1], H.H. Gutbrod[2], H. Löhner[3], M. Maier[3], A.M. Poskanzer[1], T. Renner[1], H. Riedesel[1], H.G. Ritter[2], H. Spieler[2], A. Warwick[2], F. Weik[2], H. Wieman[2]

GSI-LBL Collaboration

I. Introduction

In relativistic nuclear collisions measurement of the charged particle multiplicity of an event has been found to be an important characteristic of the underlying reaction mechanism.[1)] A further important step towards full event analysis is made very difficult because of the large dynamic range in fragment energy, fragment mass, and fragment multiplicity. In emulsion and streamer chamber studies, attempts have been made to fully reconstruct the events, but limits have had to be accepted in the quality of particle identification and total number of events analyzed. A detector system that is to favorably complement 4π detectors like emulsions, AgCl detectors, or streamer chambers, has to have the capability of detecting and identifying as many particles as possible in high multiplicity events. In the usual high-energy physics approach this would be done with many layers of multiwire proportional counters where multiparticle events are distinguished using the various combinations of wires fired. This procedure has been successfully used in combination with magnetic fields for multiplicities of 15 to 30. For

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First Experiments with the Plastic Ball

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After two and a half years of development and construction, an electronic 4π detector has been used for the first time in studying relativistic nuclear collisions. This detector complements the visual 4π detectors like emulsions, AgCl detectors, and the streamer chamber, which have been in use for many years. Only the streamer chamber has the same important feature as the Plastic Ball in being triggerable for specific event types. In a series of experiments with beams of ^{20}Ne, ^{40}Ar, and ^{40}Ca up to energies of 1.05 GeV/u, approximately three million events were measured with various trigger conditions. In contrast to the visual detectors, these events are already totally digitized and ready for immediate analysis. All multiparticle correlations of charged particles are measured in each event and do not have to be determined as an average quantity from two particle inclusive data. Besides the particle identification of the hydrogen and helium isotopes, the Plastic Ball identifies the positive pions. This makes it interesting for the study of pion production, which sets in at around 100 MeV/u incident energy, and has promise to shed some light onto the equation of state of nuclear matter. Besides the analysis of the data in the standard way of selections and of single particle inclusive data, a global analysis is in progress that should allow us to determine the reaction plane, and the event shape in phase space.

The general layout of the experiment is shown in fig. 1. The Plastic Wall, placed 6 m downstream from the target, covers the angular range from 0 to 10 degrees and measures time of flight, energy loss, and position of the reaction products. In addition, the inner counters serve together with the beam counter as a trigger.

The Plastic Ball covers the region between 10 and 160 degrees, 96% of the total solid angle. It consists of 815 detectors, where each module is a ΔE-E telescope capable of identifying the hydrogen and helium isotopes and positive pions. The ΔE measurement is performed with a 4-mm thick CaF_2 crystal and the E counter is a 36-cm long plastic scintillator. Both signals are read out by a single photomultiplier tube. Due to the different decay times of the two scintillators, ΔE and E information can be separated by gating two different ADCs at different times. The positive pions are additionally identified by measuring the delayed $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ decay. A schematic drawing of the electronics and of the timing of the different gates is shown in fig. 2.

A cluster of 13 prototype modules (a central counter and all 12 neighbors) was tested at the LAMPF low-energy pion line with monoenergetic pions and protons. The energy response curve for protons and pions and pion efficiencies could be measured in that experiment. In addition, the effect of the scattering out of particles into neighboring modules could be studied. By taking into account information from adjacent modules, this problem can be solved nearly completely[1].

Before assembling the Plastic Ball, all modules were irradiated at the Berkeley 184" cyclotron with 400 MeV and 800 MeV α beams in order to determine the high voltage for each individual photomultiplier and to measure the characteristic response of each module. A complete set of energy calibration curves for protons and all composite particles could be obtained by fragmenting the 800 MeV α beam in a thick target and by determining the energy of the fragments by a time-of-flight measurement in front of the module.

Figure 3 shows the acceptance of the Plastic Ball experiment in the plane of rapidity versus transverse momentum. In the different areas charged particles can be identified with different quality.

For the different beam-target combinations data were taken with a reaction (minimum bias) trigger and with a central trigger. The reaction trigger requests that a beam particle was identified in the start detector and that this particle lost at least one charge in a reaction with a target nucleus. The central trigger excludes reactions where particles with beam velocity (or higher velocity) are emitted within a forward cone of two degrees.

The analysis of the first experiments performed in June 1981 is in progress. Calibration factors for all detectors could be extracted from the data and test measurements so that all ΔE-E diagrams coincide. The quality of the particle separation is shown in fig. 4 for the hydrogen and helium isotopes.

Figure 5 shows the multiplicity distribution for the reaction 800 MeV/u Ne on Pb for the reaction trigger and for the central trigger (85% reduction of the trigger rate), where events with low multiplicity are strongly reduced. It is obvious that a large group of events with high multiplicity is rejected by the central trigger because in those reactions fast particles are emitted in the forward direction.

Due to the ability of identifying the particles, the Plastic Ball is well suited for investigating the emission of protons and light clusters in high energy heavy ion reactions. Such studies should yield information about the reaction mechanism and answer the question whether composite particles come from a thermalized source, or whether a coalescence process that only requires closeness in phase space of the constituents, is reponsible for cluster production. Especially the ratio of the production cross sections of deuterons to protons has been related to the entropy in the reaction zone in ref. 2. This proposition to determine the entropy from directly accessible experimental results has stimulated a vivid discussion[3-5].

Figure 6 shows that for the reaction 800 MeV/u Ne on Pb the number of protons bound in clusters increases with the multiplicity of the reaction products and equals the number of free protons in high multiplicity events. Consequently as shown in fig. 7 the deuteron to proton ratio increases with multiplicity indicating that the entropy slightly decreases.

This work was supported in part by the Director, Office of Energy Research, Division of Nuclear Physics of the Office of High Energy and Nuclear Physics of the U.S. Department of Energy under Contract DE-AC03-76SF00098.

References:

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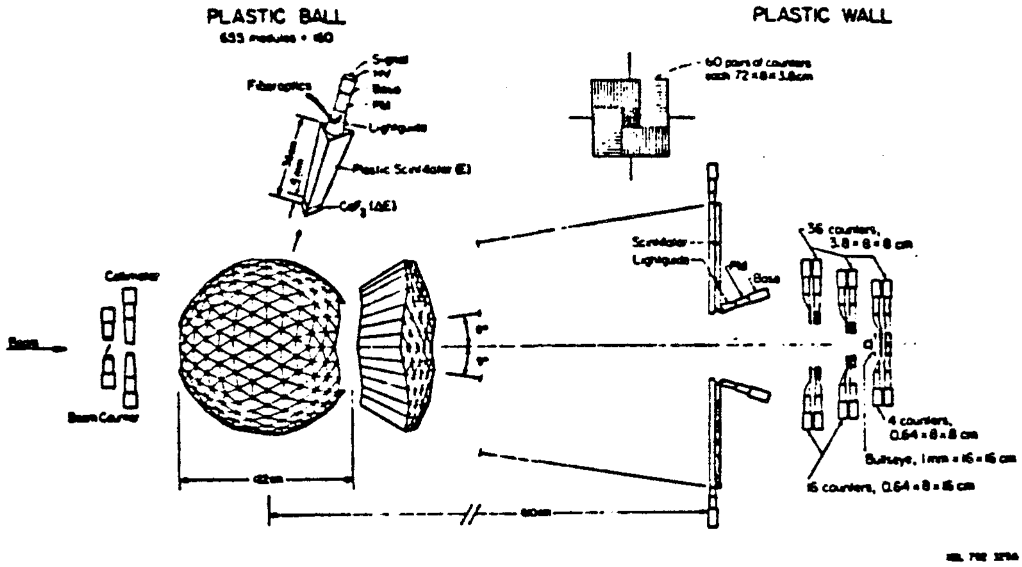

Fig. 1. General layout of the experiment

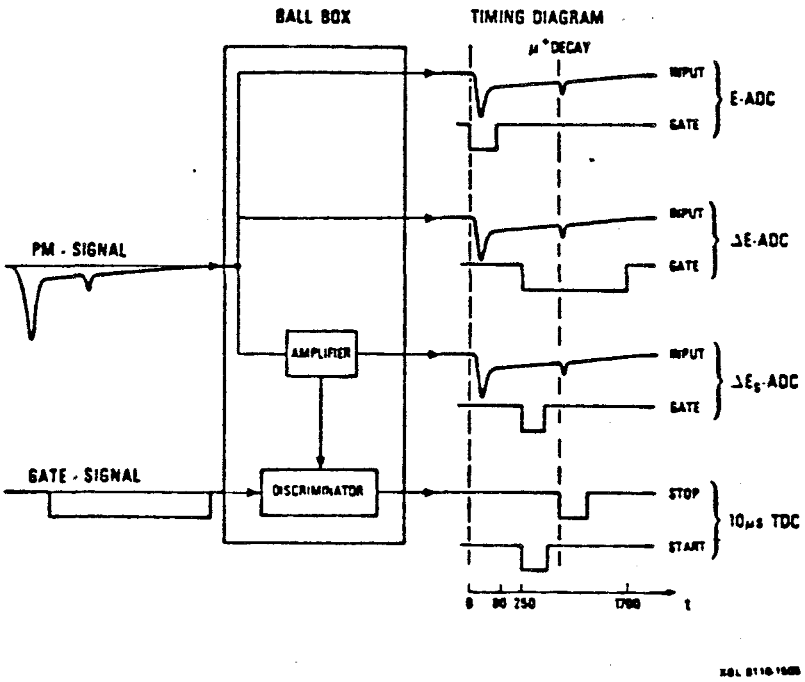

Fig. 2. Electronics scheme for one module

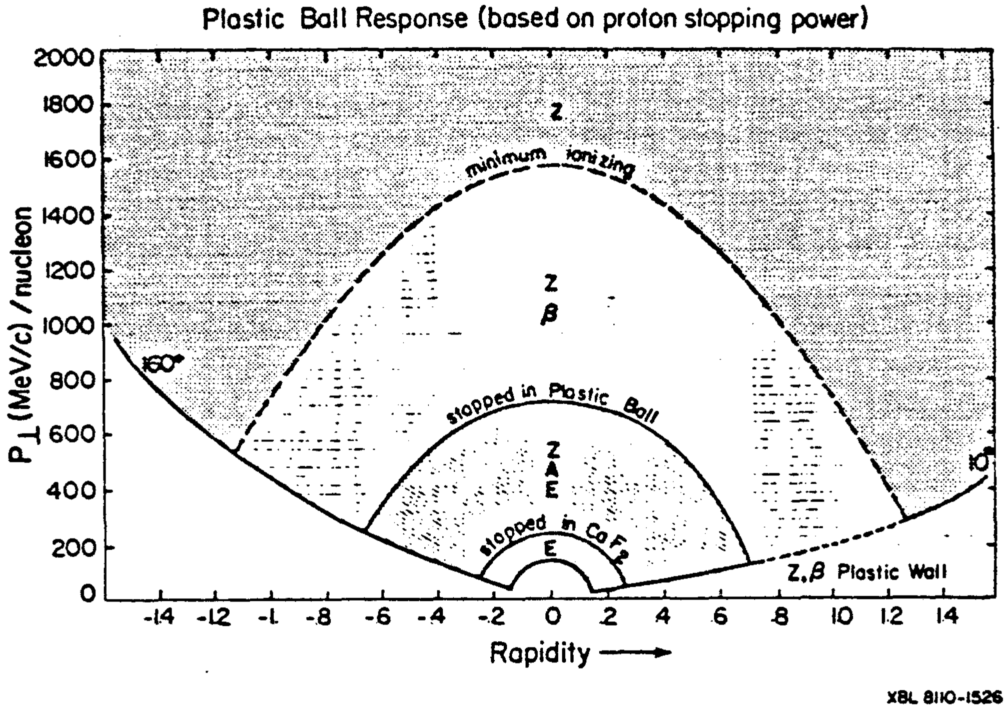

Fig. 3. Plastic Ball acceptance in the plane rapidity versus transverse momentum

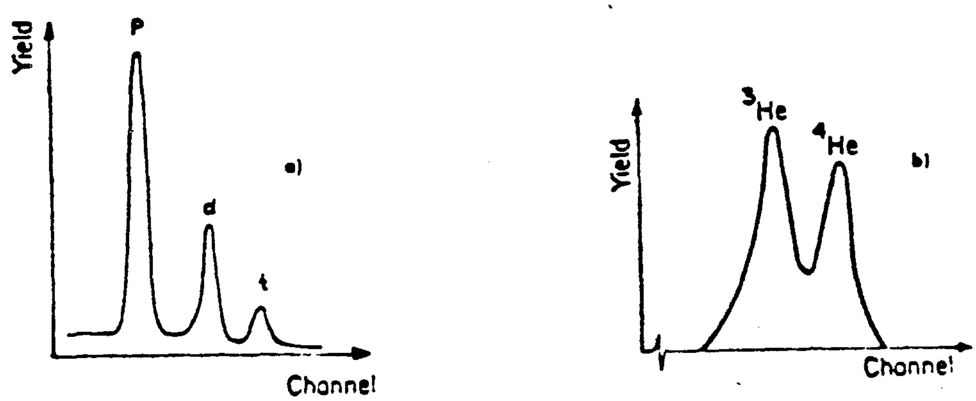

Fig. 4. Quality of the particle separation (655 modules added)
a) hydrogen isotopes, b) helium isotopes

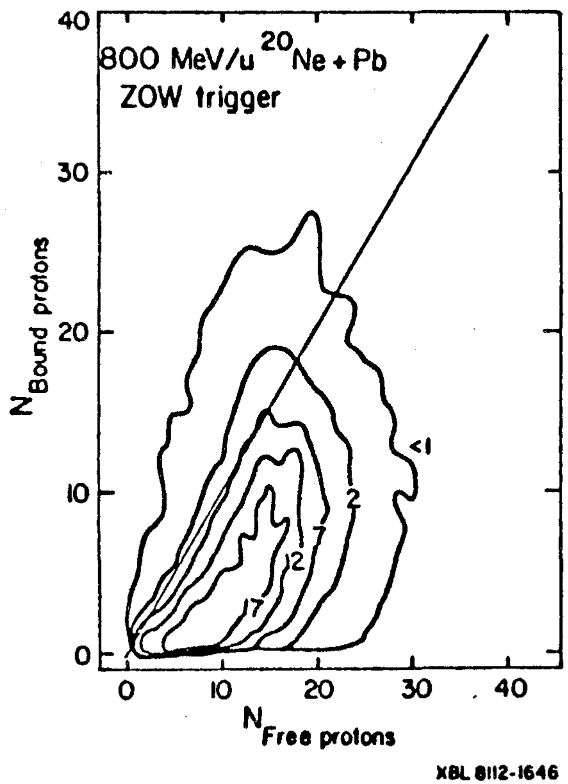

Fig. 6. Event by event contour plot of the number of free protons versus the number of protons bound in clusters

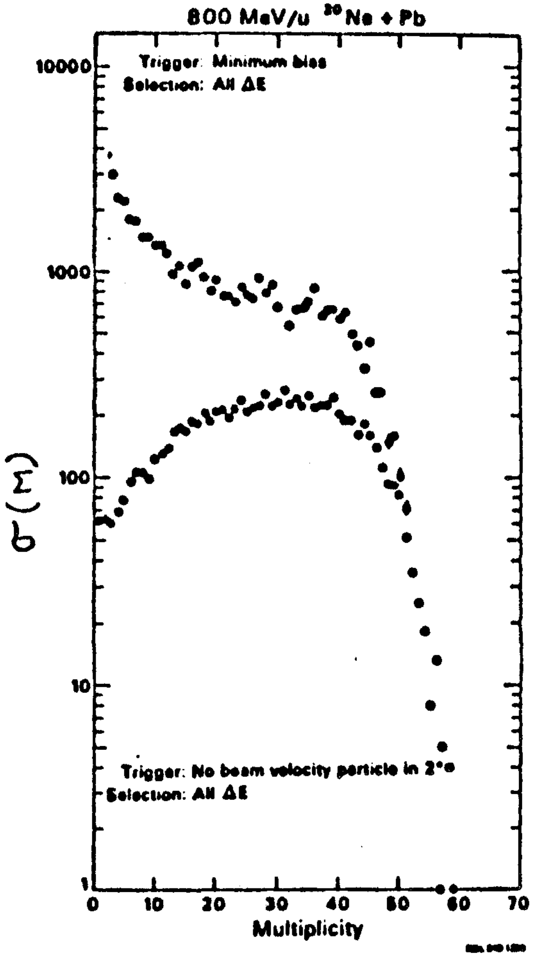

Fig. 5. Multiplicity distributions accumulated with a reaction trigger and a central trigger configuration

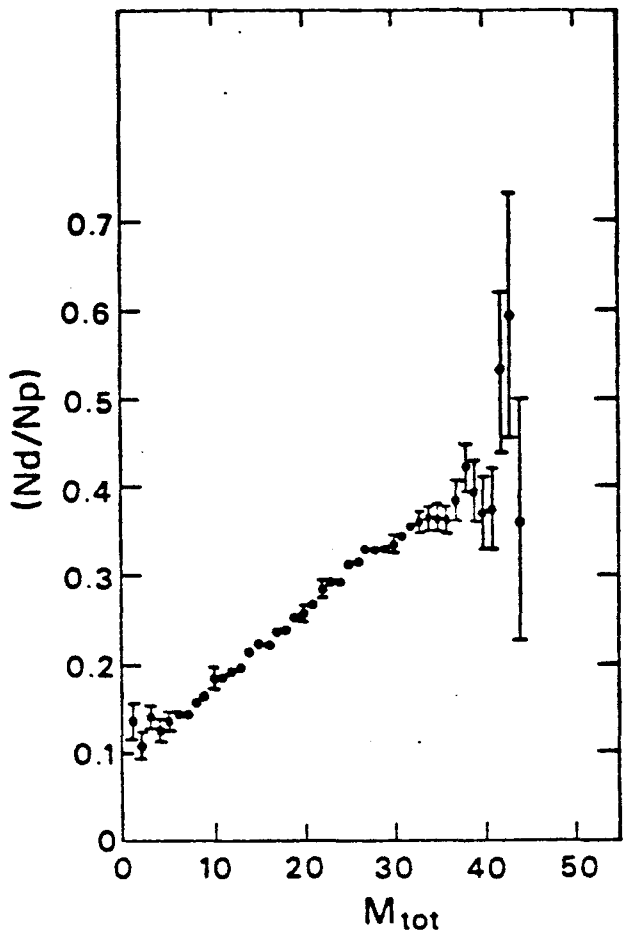

Fig. 7. Deuteron to proton ratio as a function of the total multiplicity for the reaction 800 MeV/u Ne on Pb (central trigger)