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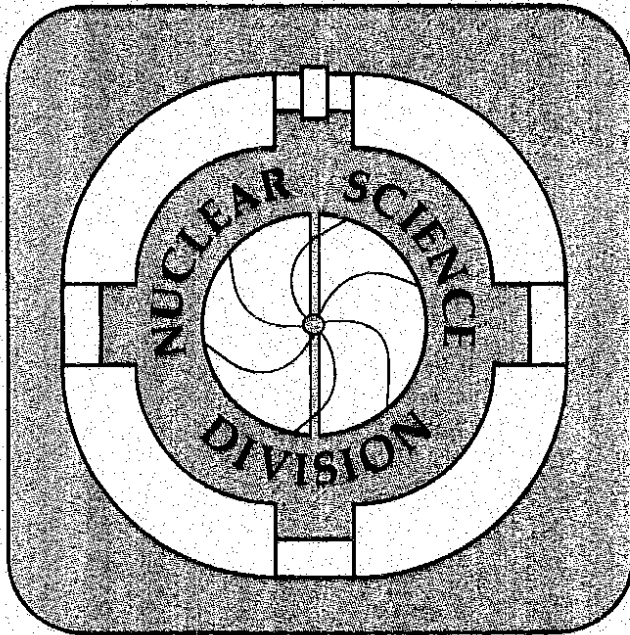
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A Measurement of Strangeness Production in 200 GeV/C/A ^{32}S and ^1p -Nucleus Interactions Using the NA36 TPC

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A MEASUREMENT OF STRANGENESS PRODUCTION IN 200 GeV/C/A ^{32}S and ^1p - NUCLEUS INTERACTIONS USING THE NA36 TPC

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ABSTRACT

Results from the NA36 experiment obtained with the ^{32}S beam at the CERN SPS during the 1987 run are presented. Production of lambda particles by proton and ^{32}S beams was studied.

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1. Introduction.

The question of Λ production, a potential signature of the Quark Gluon Plasma ¹ is addressed here. In the preceding presentation ² the experimental configuration, the performance of the TPC and analysis techniques used to identify and remove various types of background were described. Here we will discuss some aspects of our p + Pb data and then move to a more detailed discussion of the S + A (A=Al,Cu,Pb) data including preliminary results on the dependences of lambda production on transverse momentum (Pt) and violence of the collision.

2. Results from p + Pb collisions.

In figure 1 the transverse momentum spectrum for lambdas produced in p + Pb collisions at 200 GeV/c is plotted. The data are not corrected for TPC acceptance ; however, the corrections should have no major effect on the shape of the distribution in the range $0.4 < Pt < 1.5$ GeV/c. In this region the data are compatible with an exponential shape , i.e. $d\sigma / Pt^2 \sim e^{-4Pt}$, as seen in p + p data³ at 205 GeV/c. A dependence of this type is also comparable to the results reported for p + Au collisions at this conference ⁴ from the NA35 experiment. We conclude that our result for proton induced events is as expected demonstrating that the experimental method works for the range of multiplicities produced by 200 GeV/c protons on heavy targets.

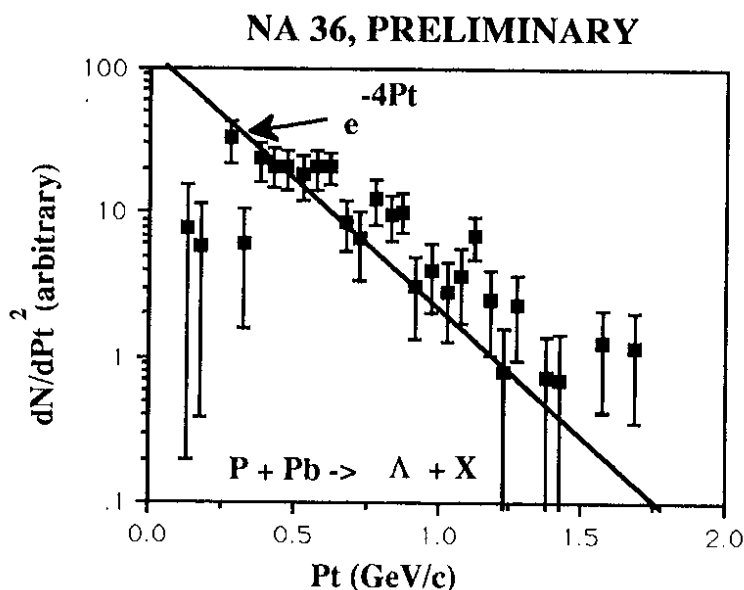


Figure 1.

Lambdas from proton beam data. Curve indicates behavior seen in p+p data.³

3. The Data from Sulfur Collisions.

¹P. Koch, B. Muller and J. Rafelski, Phys. Rep., 142(1986)367

²C. Gruhn, Proceedings of the Hadronic Matter in Collision Conference, Strangeness and Phase Transitions

³K. Jaeger, D. Colley, L. Hyman and J. Rest, Phys. Rev. D, 10(1975)2405.

⁴I. Derado, Proceedings of the Hadronic Matter in Collision Conference, Strangeness and Phase Transitions

The results on S + A collisions presented below are based on less than 3% of available data and are not acceptance corrected. We shall see later, however, that we are able to apply (preliminary) efficiency corrections for dependence on event size. The sample of data used for this analysis of S + A collisions was obtained from a run where the vertex magnet was set to a polarity which enhances the efficiency for finding lambdas since the rather soft negative pion is bent up into the TPC. Hence we concentrate on lambda results in the following. The trigger chosen yields about 50% 'central' events. The definition of 'central' was set to saturate the available data rate and corresponded to about 30% of the total nuclear cross section. The rest of the events are a mixture of minimum-bias and beam triggers taken for normalization. This data was taken with three targets (Al,Cu,Pb). Target identification codes have not been applied yet. Due to the central trigger the data are dominated by the Pb target.

4. Identification of Lambdas

The goal at this stage of the analysis was to produce a clean sample of lambdas, free of combinatorial and gamma conversion background. The first step to identify the lambda content in the data is to reconstruct all tracks in the TPC and to locate the candidates which have roughly the geometric 'VEE' signature. All pairs of positive and negative tracks are examined to see if they appear to originate from a secondary vertex near the active region of the TPC. The tracks must have a certain minimum length and indicate a neutral decay of a particle of total momentum greater than 2 GeV/c. This approach produced about 1.5 candidates per event. There are three kinds of cuts used; they relate to measurement resolution, magnetic field and decay geometry of the Λ candidates.

1. Resolution: The momentum resolution and momentum of the individual tracks were required to be consistent with the measured TPC tracking capabilities.
2. B-field: The difference in vertical (y) position at the target in a trace-back of the 2 tracks of a V has to be greater than 4 cm. This removes random combinations of tracks originating in the target. The VEE vector must point back to the target. The average value of the horizontal (z) component of the transverse momentum internal to the decay is required to be greater than 10 MeV/c. This excludes gamma conversions.
3. Geometric: Additional background sources are suppressed by rejecting a VEE vertex which is near the vacuum tank window, near the field cage or the beam. Lambdas have only been accepted when they originate more than 3.5 cm above the beam and either inside the TPC or inside the vacuum tank in front of the TPC.

The mass spectrum of the resulting candidates with $\alpha > .5$ to enhance the lambda region, is shown in Figure 2. We see that these tight cuts have produced a clean sample of lambdas in the peak at the lambda mass. The mass resolution is $\sigma = 13$. MeV.

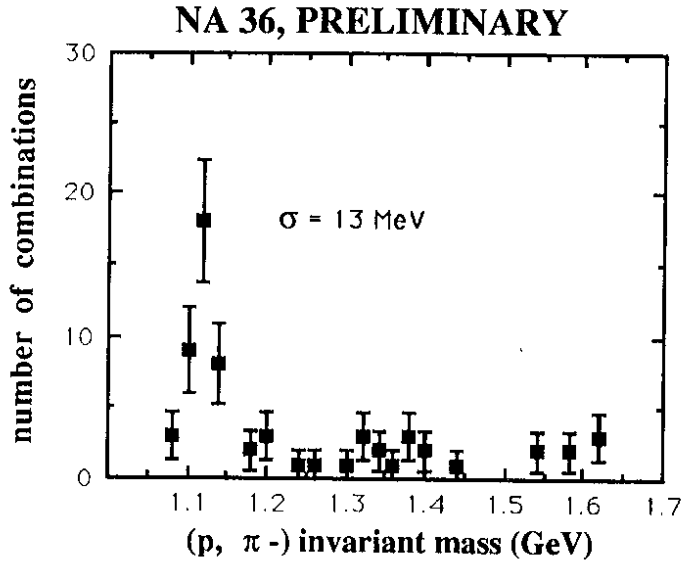


Figure 2.
Invariant mass distribution
obtained from combinations
of positive(p) and negative
(π^-) tracks.

Next the spectrum of lifetimes is investigated; Λ 's with masses between 1.06 and 1.16 GeV were selected. This leaves us with a sample of 39 lambdas. In Figure 3 we plot the normalized lifetime τ in the laboratory frame of the lambdas normalized to $\langle \tau \rangle$, and compare with the expected exponential behavior. As the data is not acceptance corrected we have left out the data below $\tau / \langle \tau \rangle = .75$. We find reasonable agreement. This gives some confidence to look at further features of Λ production.

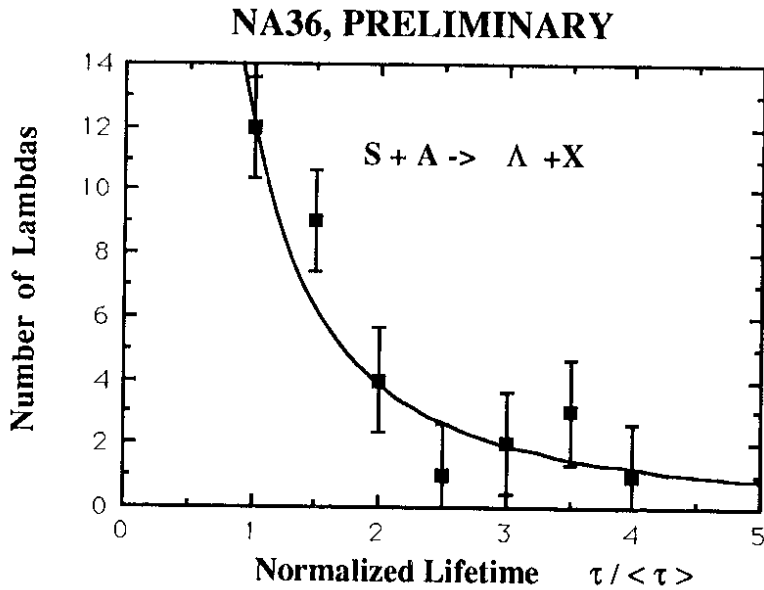


Figure 3.
Preliminary lambda lifetime
distribution. Curve indicates
the expected exponential
behavior.

The differential cross section dN/dPt^2 is shown in Figure 4 as a function of Pt . At this statistical level the shape of the distribution is close to that of the proton data (fig 1). It is interesting to note that the momentum range of NA36 and WA85 join nicely to cover the region $0.5 < Pt < 3.0 \text{ GeV}/c$ with overlap in the region $1-2 \text{ GeV}/c$.

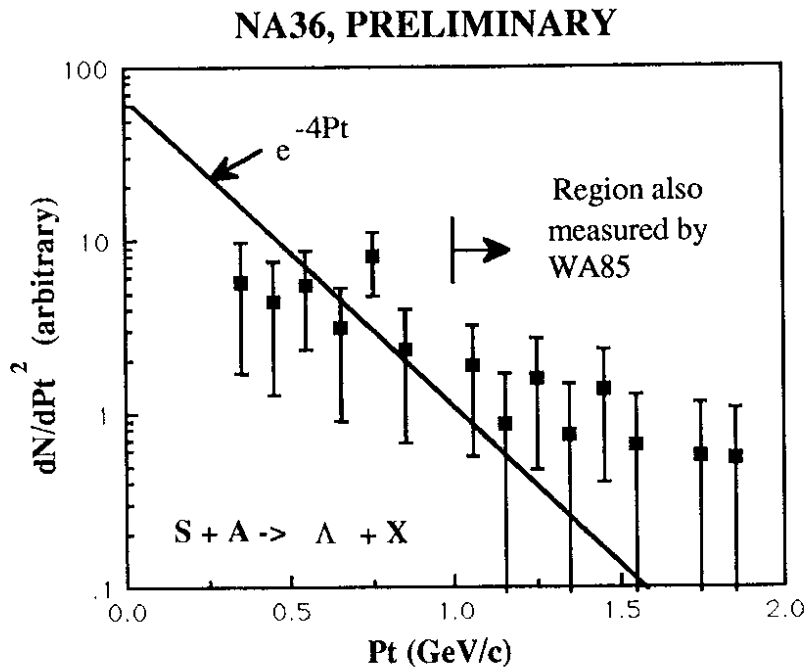


Figure 4.
Pt distribution of lambdas.
Not acceptance corrected.

NA36 was designed to be most efficient at mid-rapidity. This fact is shown in Figure 5 where the distribution of lambdas is shown as a function of their rapidity and transverse momentum. The acceptance of NA36 is roughly indicated by the bounded non-shaded area. Figure 6 shows the rapidity distribution of the lambdas.

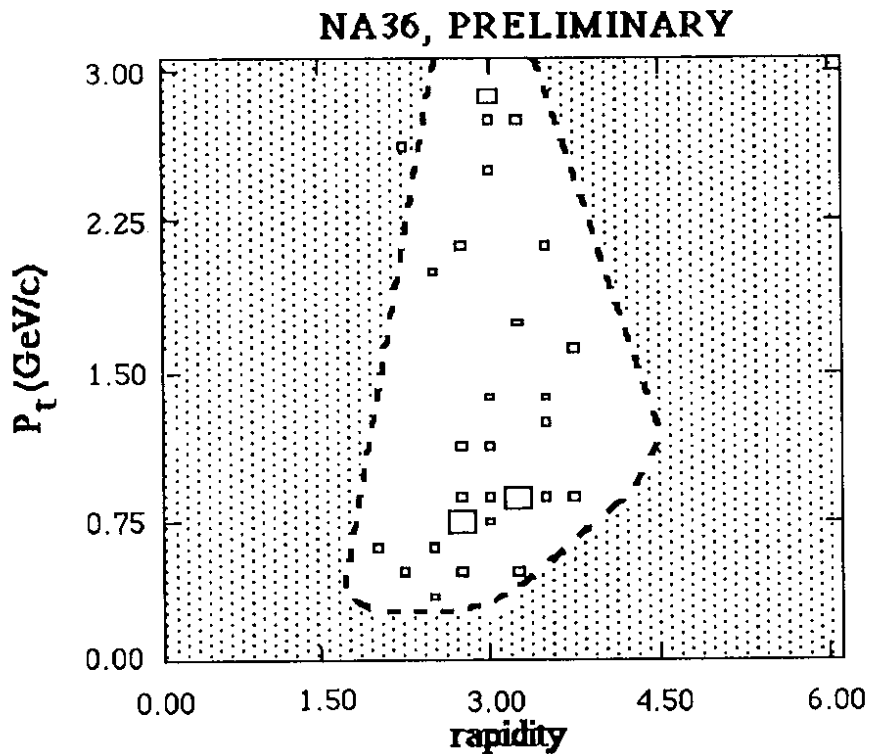


Figure 5.
Preliminary phase space
distribution of Λ 's from S + A
data. The non-shaded area
delineates roughly the region
of acceptance for lambdas
when the vertex magnet is
set to positive polarity.

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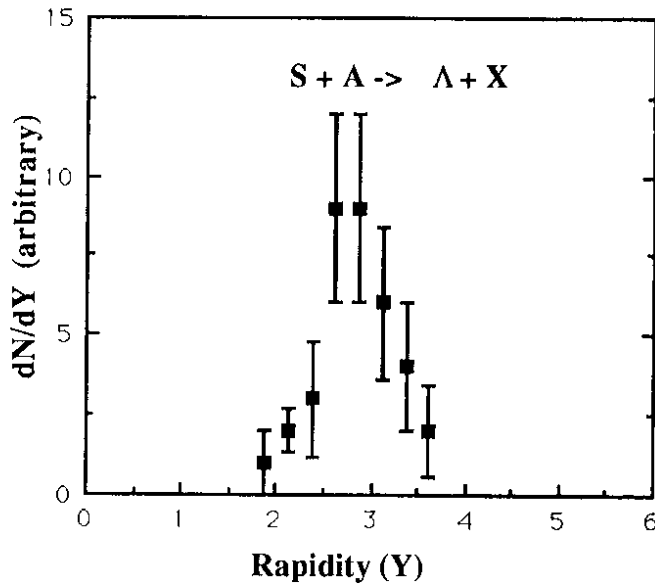


Figure 6.
Lambda rapidity distribution
Uncorrected for acceptance.

5. Dependence on event size

At the present stage of the analysis we are making improvements on the track finding algorithms. The most stable measure of event size at present is the number of hits produced by an event in the TPC. Monte-carlo simulations reveal a linear relationship between the number of hits in the TPC and the event multiplicity. However, because of delta rays, electronic noise and secondary interactions this relationship is only an approximation in the case of real data. Using the present pattern recognition a rather linear relation between the number of reconstructed tracks and hits is still found. In the following we will use the number of hits in the TPC as a parameter to measure event size.

In order to investigate the dependence of lambda production on event size, we must determine the lambda reconstruction efficiency as a function of the number of hits in an event. The method we have applied to do this makes use of the p + Pb data where a sample of lambdas was obtained in rather low multiplicity events. We extract these lambdas and then embed them in S + A events corresponding to different numbers of TPC hits. This artificial data is then analyzed by the standard analysis program and the efficiencies are determined. This is a method rather unique to electronic detectors which optimally simulates event and background features, as well as the response of electronics. This is our first attempt to determine these relative efficiencies and we expect to improve on it. We show in Figure 7 the efficiency relative to the efficiency achieved in the p + Pb data. Although the relative efficiency drops a factor of about ten for very central events, the weighted average relative efficiency is 25%.

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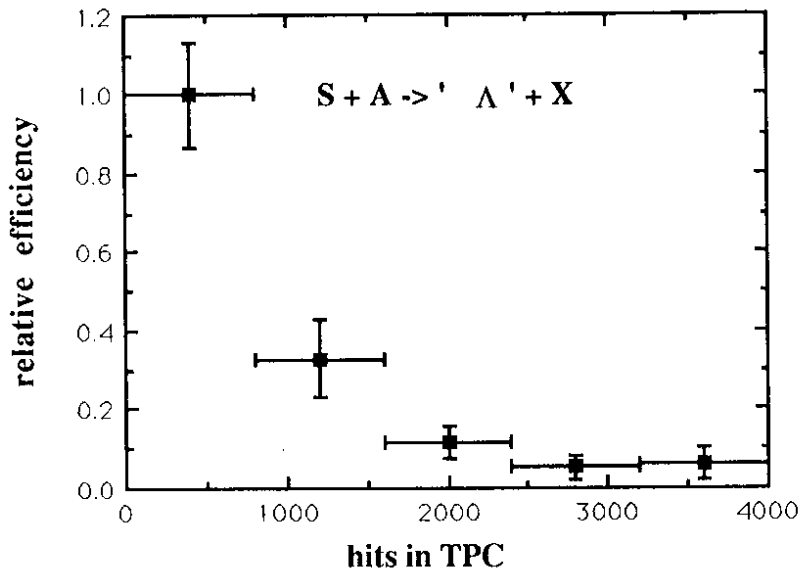


Figure 7.
Relative lambda detection efficiency as a function of the number of hits in the TPC per event.

Now that this function is known it is possible to consider the dependence of the lambda flux on the size of the events. Multiplying the flux of reconstructed Λ 's in S + A events by the measured efficiency gives the resultant flux as a function of the number of hits in the TPC in Figure 8. All errors are statistical. As the data sample is target averaged over three different targets and expressed as a function of the number of hits in the TPC no direct comparison with other results is possible at present. Primarily the capability is demonstrated to examine questions such as multiplicity dependence of lambda production. From increased statistics, target identification and pattern recognition improvements more precise results of physics quantities will be presented elsewhere in the near future.

NA36, PRELIMINARY

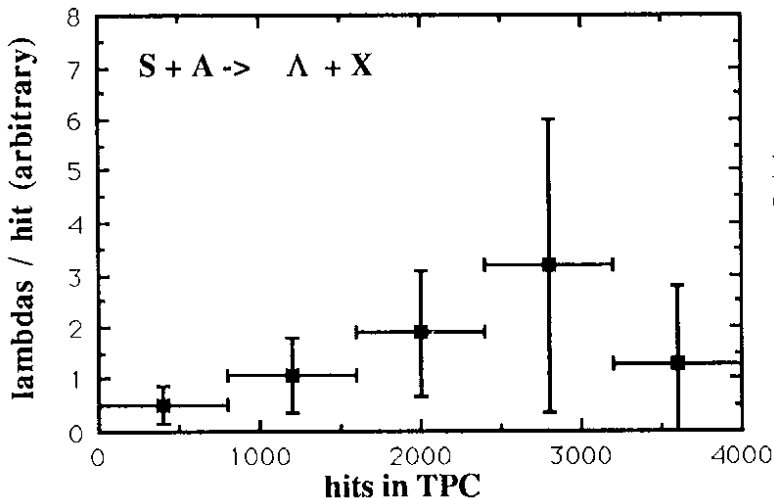


Figure 8.
Dependence of observed lambdas on the number of hits in the TPC.

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