

π^- production in p+C collisions at 31 GeV

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Abstract

Evidence for the onset of deconfinement in central Pb+Pb collisions was reported by NA49 at the CERN SPS at collision energy 30A GeV. This observation motivated the NA61/SHINE ion program which, in particular, aims to study properties of the onset of deconfinement by measurements of hadron production in p+p, p+A and nucleus-nucleus collisions at the SPS energies. The program started in 2009 when p+p interactions at 20, 31, 40, 80, and 158 GeV were recorded. This contribution presents preliminary spectra of negatively charged pions produced in p+C interactions at 31 GeV. The NA61 results are compared with the corresponding NA49 data from central Pb+Pb collisions at this energy.

1. Physics program of NA61/SHINE

NA61/SHINE (SPS Heavy Ion and Neutrino Experiment) is a fixed-target experiment at CERN SPS. The physics program consists of three subjects:

- measurements of **hadron production in proton-nucleus interactions** needed for neutrino and cosmic ray experiments (2007-2010),
- measurements of **hadron production in proton-proton and proton-nucleus interactions at 158A GeV** as reference data for better understanding of nucleus-nucleus reactions (2010-2012),
- measurement of **the energy dependence of hadron production properties in nucleus-nucleus collisions as well as p+p and p+Pb interactions** (2009-2015). The aim is to identify the properties of the onset of deconfinement and find the critical point of strongly interacting matter.

2. Pion production

In statistical models pion multiplicity is approximately proportional to the entropy. Therefore it is an important probe in the study of the onset of deconfinement [1].

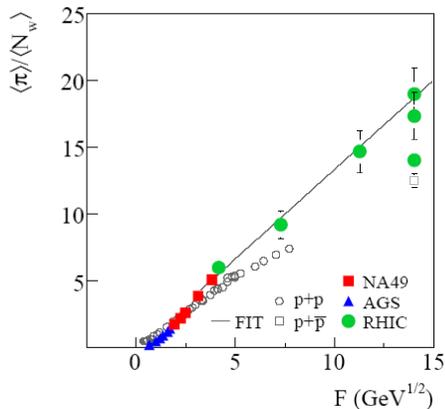


Fig.1 Energy dependence of the pion production yield scaled by the number of wounded nucleons, as a function of energy. The coloured points corresponding A+A collisions show a "kink" structure, absent in the p+p data [2].

The existing results presented in Fig. 1 show significant differences in the energy dependence of pion production in p+p and A+A collisions. This is interpreted as a signature of the onset of deconfinement starting at 30A GeV.

3. NA61 detector

THE main detectors the NA61/SHINE are 5 Time Projection Chambers. 3 of them are located inside the superconducting magnets allowing for charge and momentum measurement. In addition there are Time-of-Flight detectors. Particle identification is possible by the measurement of the energy loss in the gas of the TPCs and the time of flight. The schematic of the detector is presented in Fig. 2.

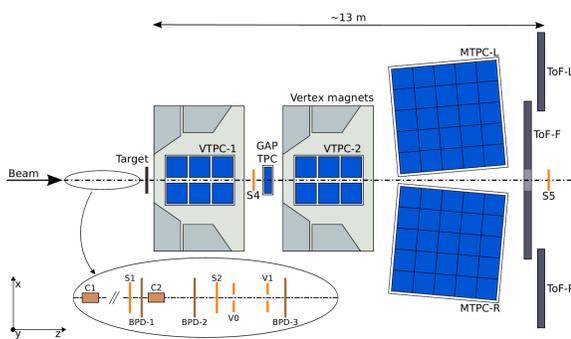


Fig.2 Schematic layout of the NA61/SHINE detector

4. Analysis method

MORE than 90% of primary negatively charged particles produced in p+C interactions at 31 GeV are negatively charged pions. Thus π^- meson spectra can be obtained by subtracting the estimated non-pion contribution from the spectra of negatively charged particles and additional particle identification is not required.

First, spectra of all accepted negatively charged particles were obtained. Second, the Monte Carlo simulation was used to calculate corrections for the contribution of both primary and secondary negative particles other than π^- . Furthermore, the corrections include track reconstruction efficiency and resolution as well as losses due to the limited geometrical acceptance of the detector. Bin-by-bin correction factors were calculated as the ratio of all generated primary π^- mesons to all reconstructed and accepted negatively charged particles in a given bin [3].

5. Preliminary results

THE plots below show the π^- spectra as function of transverse mass and rapidity from p+C interactions at 31 GeV. They are compared to the corresponding results from central Pb+Pb collisions at 30A GeV measured by the NA49 experiment [2].

Figures show only statistical errors. Based on [4] the systematic error is estimated to be 5-8% for $p > 2$ GeV/c and 10-15% (mostly due to the electron contamination) for $p < 2$ GeV/c.

The transverse mass spectra for p+C and Pb+Pb (Fig. 3) are fitted with an exponential function in the range $0.2 < m_T < 0.7$ GeV. Their ratio is shown at Fig. 4.

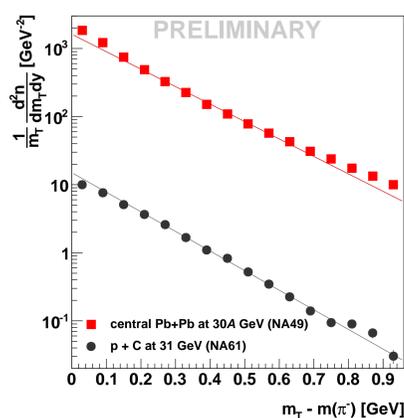


Fig.3 Transverse mass spectra of π^- at midrapidity ($0 < y < 0.2$).

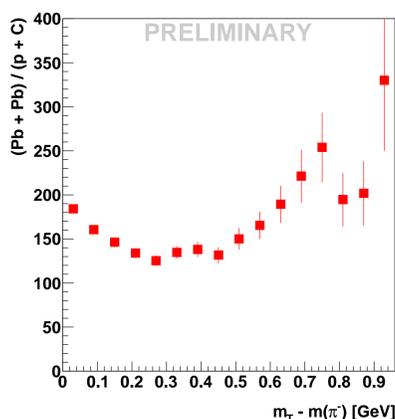


Fig.4 Ratio of π^- transverse mass spectra from central Pb+Pb and p+C collisions.

The rapidity spectra are shown in Figs. 5-7. In the first approximation they should scale with the wounded nucleon number. The predicted wounded projectile nucleon ratio is indicated by the horizontal line in Fig. 6. The Pb+Pb points

in Fig. 7 are scaled by this ratio. The rapidity spectra were fitted with the Gaussian function. For Pb+Pb collisions the mean value was fixed at 0.

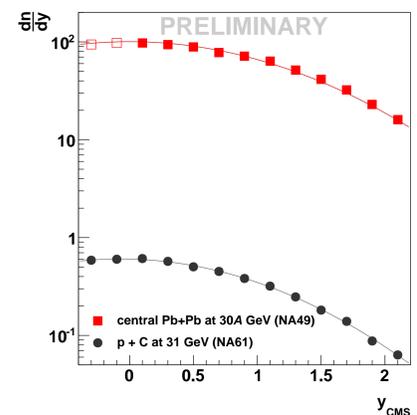


Fig.5 Rapidity spectra of π^- for $0 < p_T < 1$ GeV/c with Gaussian fits. The loss from the p_T limit is estimated to be less than 2%. The open symbols are reflection of Pb+Pb data at $y = 0$.

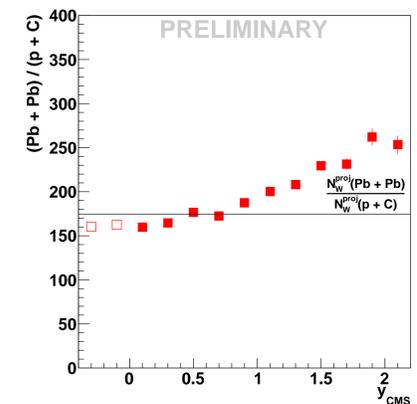


Fig.6 Ratio of the π^- rapidity spectra from Pb+Pb and p+C collisions. The horizontal line shows the ratio of the wounded projectile nucleons.

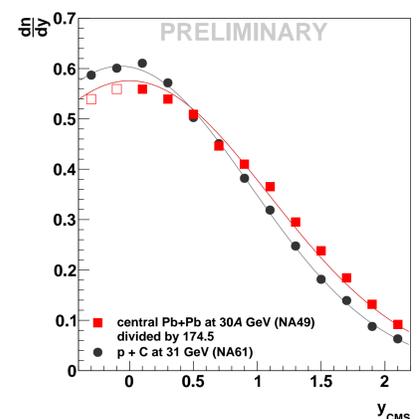


Fig.7 Rapidity spectra of π^- . The Pb+Pb spectrum was scaled by the ratio of the number wounded projectile nucleons.

References

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