π^+ and π^-mutliplicities measured in p+C interactions at 31 GeV/c in NA61/SHINE for the T2K experiment.

Magdalena Posiadała-Zezula, for the NA61/SHINE Collaboration

Faculty of Physics, University of Warsaw, Hoża 69, 00-681 Warsaw, Poland

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Abstract

The T2K (Tokai-to-Kamioka) is a second generation long baseline neutrino oscillation experiment which, for the first time in the world, was able to detect $\nu_\mu \to \nu_e$ appearance [1] and as a result the mixing angle parameter θ_{13} could be measured. The T2K neutrino beam predictions require knowledge of the hadron production in proton-carbon interactions at 31 GeV/c. The NA61/SHINE (SHINE = SPS Heavy Ion and Neutrino Experiment) comes into importance as in the first stage of data taking (2007-2010) it aimed to deliver data needed for the T2K. This experiment is a large acceptance hadron spectrometer located in the North Area H2 beam line of the CERN SPS. The main tracking and particle identification devices are large volume Time Projection Chambers (TPCs) and Time-of-Flight detectors (ToF).

Multiplicities of charged pions measured with NA61/SHINE data collected during the 2009 run with an isotropic graphite target with a thickness of 4% of a nuclear interaction length are presented. These spectra were obtained with dE/dx measurements and are compared with limited in statistics results from the 2007 run [2] as well as merged with the results obtained on the 2009 data using combined analysis of dE/dx+ToF.

The NA61/SHINE experiment

The NA61/SHINE apparatus is a wide acceptance spectrometer at the CERN SPS. The detector is built arround five Time Projection Chambers (TPCs), see Fig. .

In the NA61/SHINE experiment particle identification is possible using energy loss measurements ($\frac{dE}{dx}$) in the active volume of the TPCs and time-of-flight information from ToF detectors.

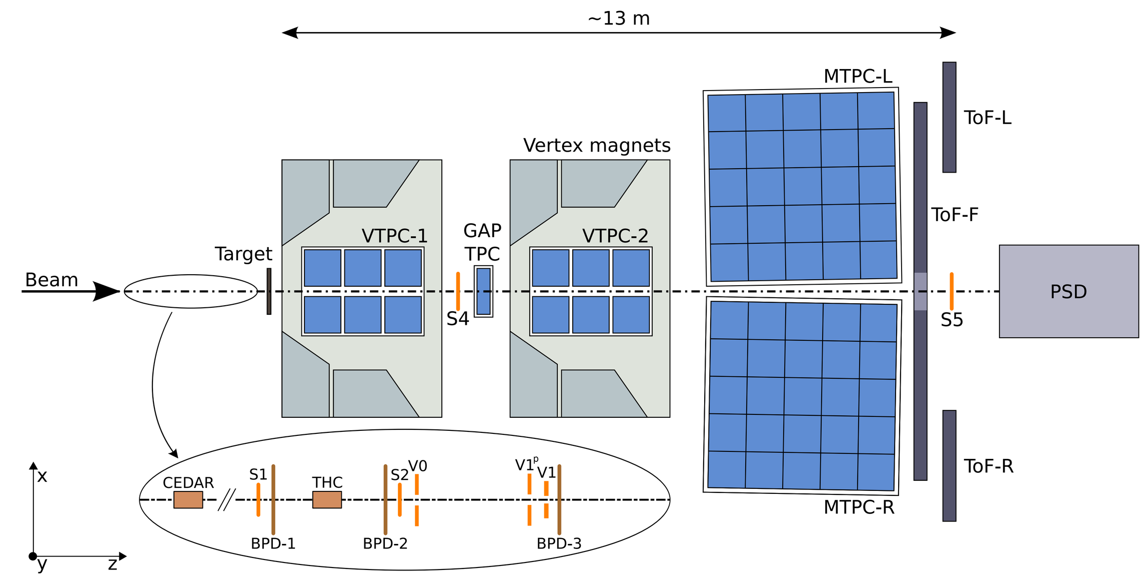

FIGURE 1: The schematic layout of the NA61/SHINE spectrometer (horizontal cut, not to scale). The magnetic field bends charged particle trajectories in the x–z (horizontal) plane.

The calibrated dE/dx distributions as a function of particle momentum

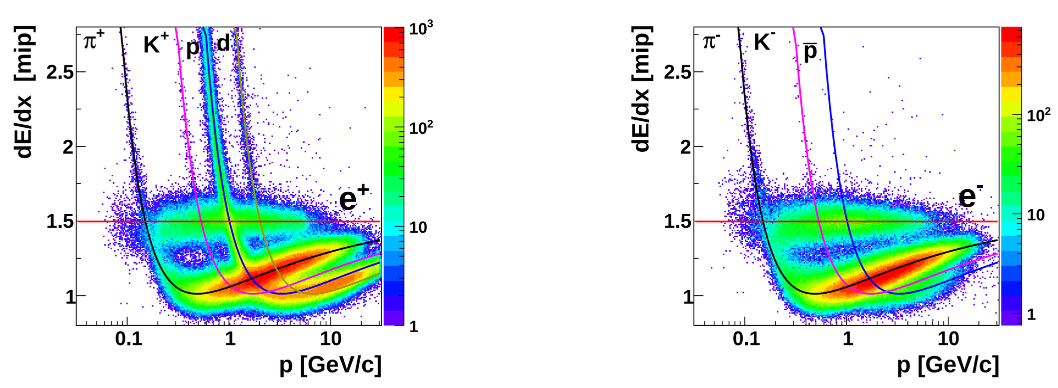

FIGURE 2: The calibrated dE/dx distributions as a function of particle momentum for positively and negatively charged particles are presented. The Bethe-Bloch parametrization of the mean energy loss, scaled to the experimental data, is shown by the curves for positrons (electrons), pions, kaons, protons, and deuterons.

Maximum likelihood fit

The identification procedure was performed in (p, θ) bins. Narrow momentum intervals (of 0.1 GeV/c for $p < 1$ GeV/c) were chosen to account for the strong dependence of dE/dx on momentum. In each (p, θ) bin an unbinned maximum likelihood fit (for details see Ref. [4]) was performed to extract yields of π^+ and π^- mesons. The probability density functions were assumed to be a sum of Gaussian functions for each particle species.

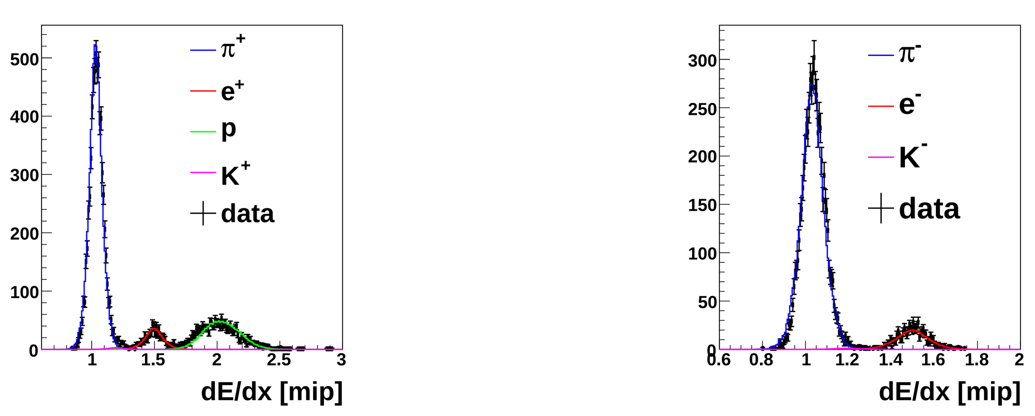

FIGURE 3: The dE/dx distributions for positively (left) and negatively (right) charged particles in the momentum bin [0.7,0.8] GeV/c and angular bin [180,240] mrad compared with the distribution calculated using the fitted relative abundances.

Multiplicities of π^+ and π^- for low momentum region

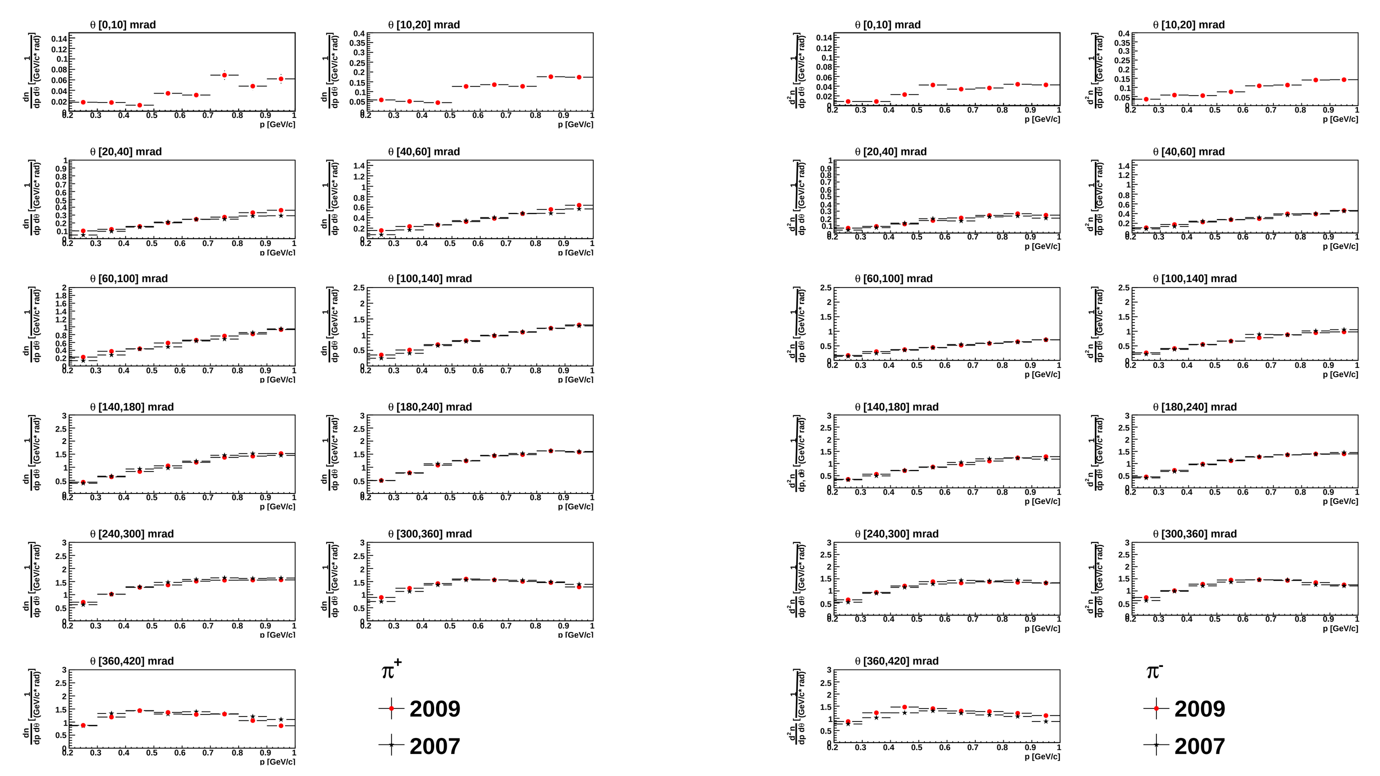

FIGURE 4: Multiplicities of π^+ (*left*) and π^- (*right*) for low momentum region obtained with dE/dx mesurements. Two data sets are shown: limited in statistics 2007 results as well as recent preliminary results from 2009 data set.

Multiplicities of π^+ and π^- obtained with different analyses techniques

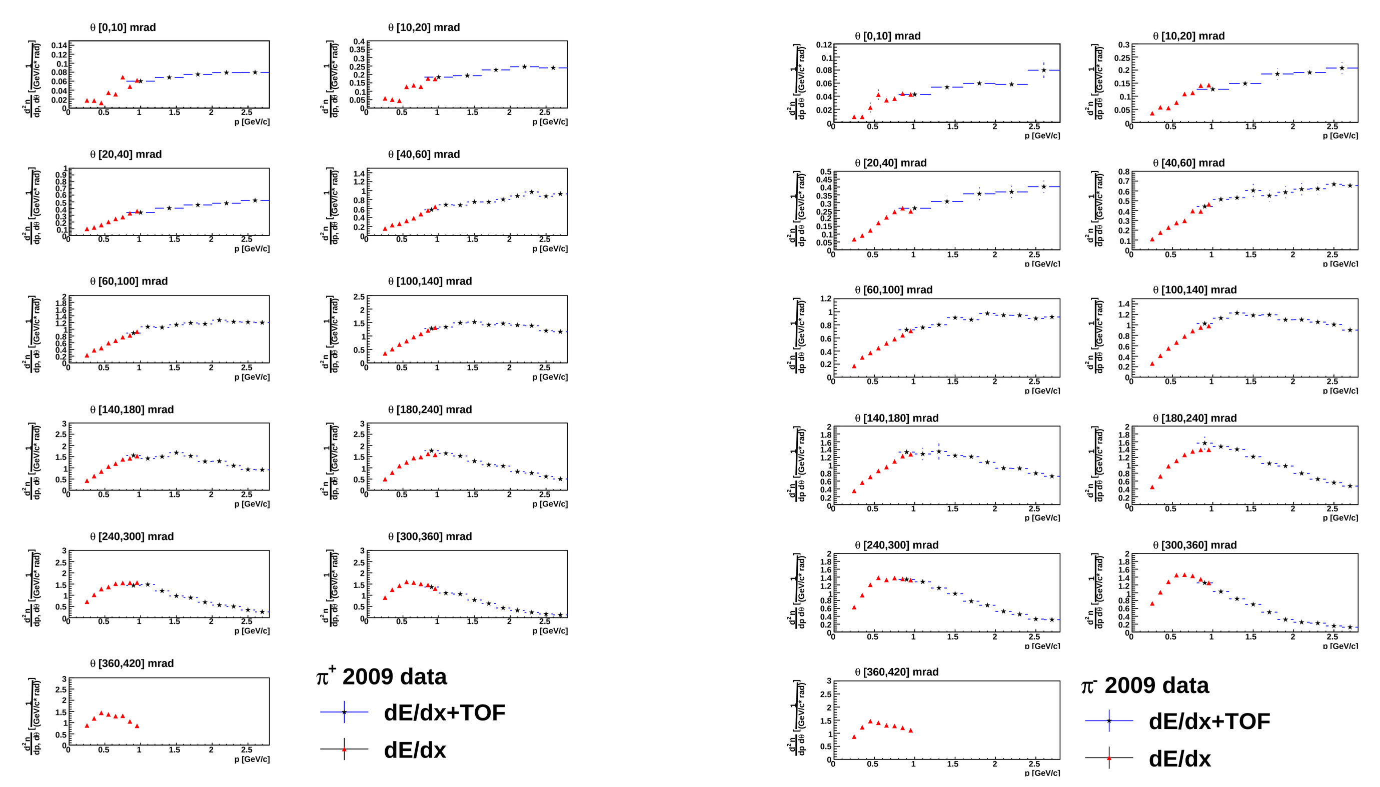

FIGURE 5: Multiplicities of π^+ (*left*) and π^- (*right*) determined at low momenta with dE/dx only (red points) together with results from dE/dx+ToF analysis (blue points). The result from dE/dx+ToF are shown only for zoomed region, p≲3GeV/c.

References

[1] K. Abe *et al.* [T2K Collaboration], *Observation of Electron Neutrino Appearance in a Muon Neutrino Beam*, Phys.Rev.Lett.**112**, 061802 (2014).

[2] N. Abgrall *et al.*, [NA61/SHINE Collaboration], *Measurements of Cross Sections and Charged Pion Spectra in Proton–Carbon Interactions at 31 GeV/c*, Phys. Rev. **C84**, 034604, (2011).

[3] K. Abe *et al.* [T2K Collaboration], *The T2K Neutrino Flux Prediction*, Phys.Rev. **D87**, 012001 (2013).

[4] M. Posiadała, PhD thesis, *Measurements of Hadronic Cross Section for Precise Determination of Neutrino Beam Properties in T2K Oscillation Experiment*, University of Warsaw, Poland, 2012.