Conference Paper

Forward yields of the secondary light nuclei in CC-collisions at beam energy 20.5 GeV/n on the accelerator U-70 in comparison with models UrQMD, FTFP-BERT-EMV and QGSP-FTFP-BERT-EMV in the framework of Geant4

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Abstract

The zero angle production of light nuclei has been studied in CC-interactions at beam energy 20.5 GeV/n on accelerator U-70. The measurements were performed with employing of the beamline no. 22 as spectrometer of secondary particles with verying its rigidity from 10 to 70 GeV/c. We observed secondary protons and deuterons with momenta above kinematic limit of NN-interactions. The measured dependence of forward yields on momentum are compared with the model predictions in the framework of Geant4. The models more or less correctly give positions of maxima of the distributions and their general qualitative dependence on the momentum. But in the quantitative predictions of the yields there are significant differences with the experiment which grow with increase of atomic mass number A.

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1. Introduction

The carbon beams on accelerator U-70 in IHEP (Protvino) opened new possibilities in relativistic nuclear physics. To study the forward production of particles and nuclear fragments in AA- interactions in new energy range we use the beamline no. 22 as spectrometer of the secondary particles with verying its rigidity from 10 to 70 GeV/c. The Monte-Carlo simulation of beam line no. 22 as spectrometer done in work [1] in the framework of Geant4. In paper [2] the first results of experiment are presented where one can also find the general scheme of the used setup and details of the experimental procedures.

Existing data on forward yields of light nuclei in AA-interactions obtained at essentially lower energies (about 0.3-2 GeV/n) [3 - 6] than in our experiment. In this work we study zero angle production in CC-collisions at energy 20.5 GeV/n. The experimental data are compared with models UrQMD (version 4.3) [7], FTFP-BERT-EMV and QGSP-FTFP-BERT-EMV in the framework of Geant4 (version 10.02.p02) [8].

UrQMD model is based on the Ultrarelativistic Quantum Molecular Dynamics. FTFP-BERT-EMV [9, 10] is built from several components like AA model Fritiof handling the formation of initial strings and following them fragmentation into hadrons according to the Lund model in the framework of Bertini cascade, de-excitation of the remnant nucleus in the precompaund part and CPU oprimization of electromagnetics. QGSP-FTFP-BERT-EMV additionally to previous includes hA quark gluon string precompound model.

2. Experimental results

The nuclear targets are placed in the head of the beam line. At its end recording equipments of one of two arms of the spectrometer FODS [11] are installed: scintillating and threshold Cherenkov counters, ring-imaging Cherenkov spectrometer (RIC) [12] and hadron calorimeter [13].

2D-plots A vs Z in Fig.1 show selection of the nuclear fragments in the end of beam line no. 22 at different its rigidities p: 38, 47 and 60 GeV/c. Values A and Z are measured atomic mass number and charge of the fragment defined respectively through amplitude analysis of the signals from scintillating counters and hadron calorimeter.

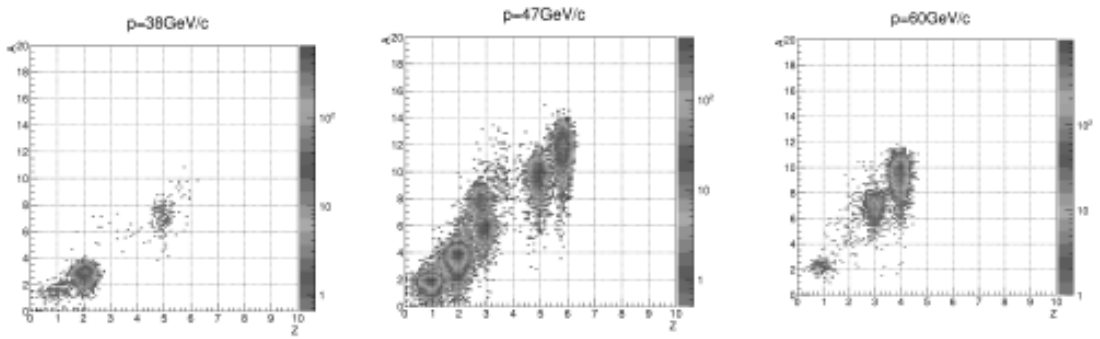

Figure 1: 2D-plots of measured values A vs Z in the end of beam line no. 22 at different its rigidities p: 38, 47 and 60 GeV/c, where A and Z are respectively atomic mass number and charge of the secondary nuclear fragment.

Fig. 2 demonstrates 2D-plot M vs ratio r=H/p at rigidity of the beam line p=35.18 GeV/c, where M is mass of the nuclear fragment reconstructed in RIC and H is the signal from hadron calorimeter. There are two divided regions on this plots: for proton

(lower region) and deuteron (upper region). The kinematic limit of NN-interaction for the ratio r corresponds to the value r=20.5/35.18=0.58 while one can see essential population on the plot in the kinematically forbidden region r>0.58.

Yields of the secondary nuclear fragments with atomic mass number A=1,2,3, Z=1 and A=3,4,6, Z=2 are shown respectively in Fig. 3 and 4. The models more or less correctly give positions of maxima of the distributions and their general qualitative dependence on the momentum. But in the quantitative predictions of the yields there are significant differences with the experiment which grow with increase of atomic mass number A for the fragment.

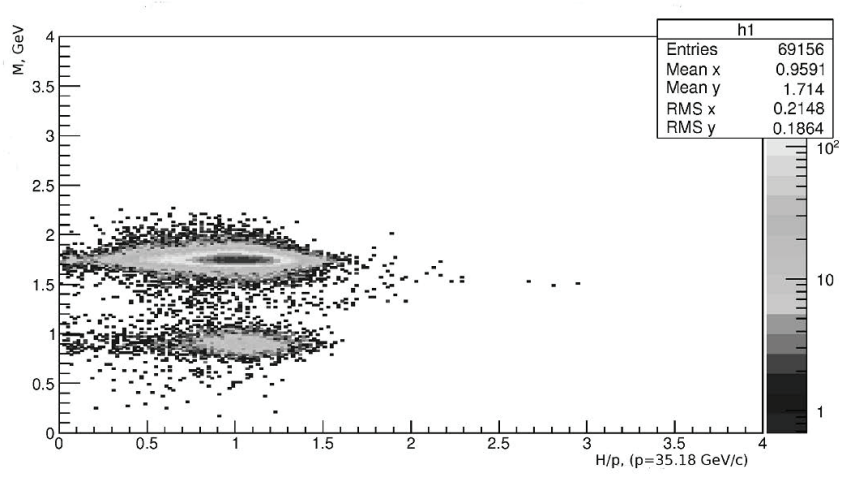

Figure 2: 2D-plot M vs ratio r=H/p at rigidity of the beam line p=35.18 GeV/c, where M is mass of the nuclear fragment reconstructed in RIC and H is the signal from hadron calorimeter (kinematic limit of NN-interaction for the ratio r corresponds to the value r=20.5/35.18=0.58).

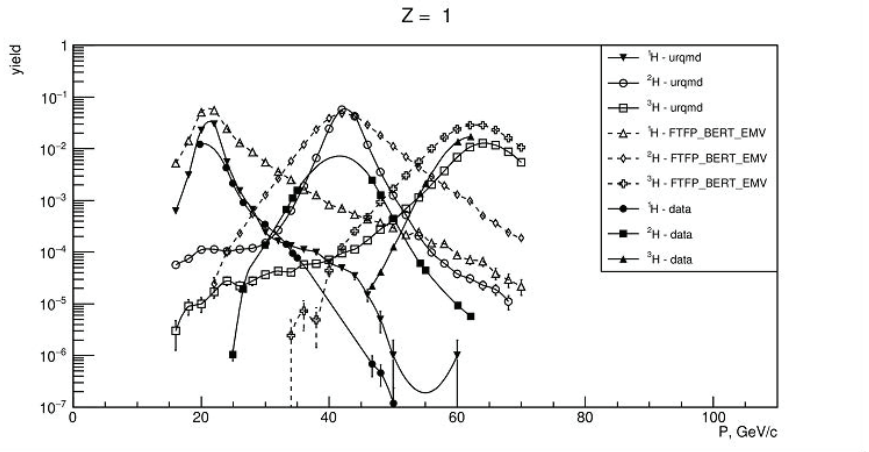

Figure 3: Yields of the secondary nuclear fragments with atomic mass number A=1,2,3 and Z=1 at the end of the beamline no. 22 in dependence on its (total) momentum p in comparison with models UrQMD, FTFP-BERT-EMV (model QGSP-FTFP-BERT-EMV coincides with FTFP-BERT-EMV).

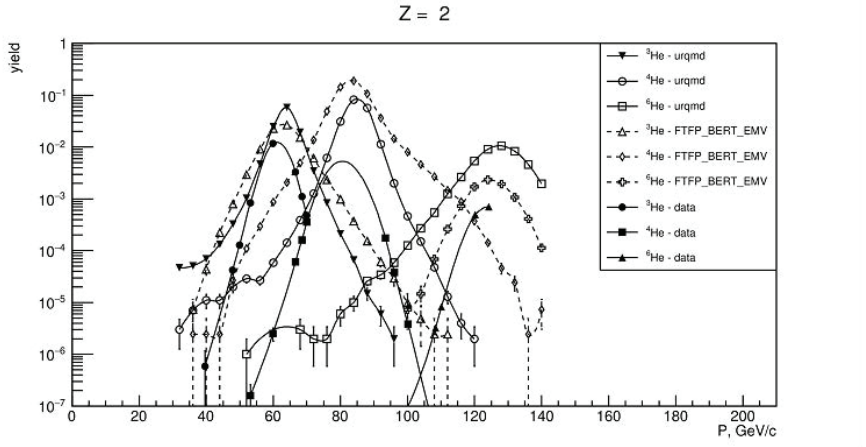

Figure 4: Yields of the secondary nuclear fragments with atomic mass number A=3,4,6 and Z=2 at the end of the beamline no. 22 in dependence on its (total) momentum p in comparison with models UrQMD, FTFP-BERT-EMV (model QGSP-FTFP-BERT-EMV coincides with FTFP-BERT-EMV).

3. Conclusions

At the studying of zero angle production of light nuclei in CC-interactions at new energy range 20.5 GeV/n we observed secondary protons and deuterons with momenta above kinematic limit of NN-interactions.

It was measured the dependence of forward yields of light nuclear fragments on its momentum *p*. The models more or less correctly give positions of maxima of the distributions and their general qualitative dependence on *p*. The observed quantitative difference between the models and the experiment data requires additional study of the causes of discrepancies.

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