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ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ БЮДЖЕТНОЕ УЧРЕЖДЕНИЕ НАУКИ Физический институт имени П.Н.Лебедева РОССИЙСКОЙ АКАДЕМИИ НАУК ФИАН

ON THE POSSIBILITY OF CONTROL THE MAXIMUM ENERGY OF FAST NEUTRONS BY THE PULSE HEIGHT SPECTRA OF THE ^{10}B-DETECTOR

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Introduction

Measuring energy in an intense flux of fast neutrons from a source based on reactors and accelerators is an important but very difficult task.

Activation detectors : give only a general picture of the neutron field, requires the use of expensive germanium detector and complex analysis carried out when the experiment is over.

Scintillation detectors are highly sensitive to γ- and X-ray quanta with intensity significantly exceeds neutron flux, large mass distorts neutron field.

Proportional and ionization chambers and counters filled with ^{3}He or $^{10}BF_3$ gases have a high efficiency only for slow and epithermal neutrons.

All of the above mentioned detectors measure the neutron flux under a scattered neutron high background and have not directional selectivity

Method for energy measurement : recoil proton and time-of-flight

Position-sensitive hybrid detector: ^{10}B-layer + MWPC

Paper on the two dimensional position-sensitive neutron detector is published in [S.Potashev..EPJ Web of Conf. 231,05010 (2020)]

It has following advantages before all other detectors:

a) It is suitable to operate in the intense flux of fast neutrons.

b) It has extremely low sensitivity to γ-quanta and X-ray.

c) Two-dimentional pulse height and position data are acquired in runtime.

d) A small mass of substance in the neutron flux and low neutron scattering.

e) Detector has directional selectivity.

f) Linear relationship between ionization energy loss and pulse height.

g) It has enough efficiency to measure neutrons at from 1 to 7 MeV.

h) The neutron energy is unambigously depends on the pulse height.

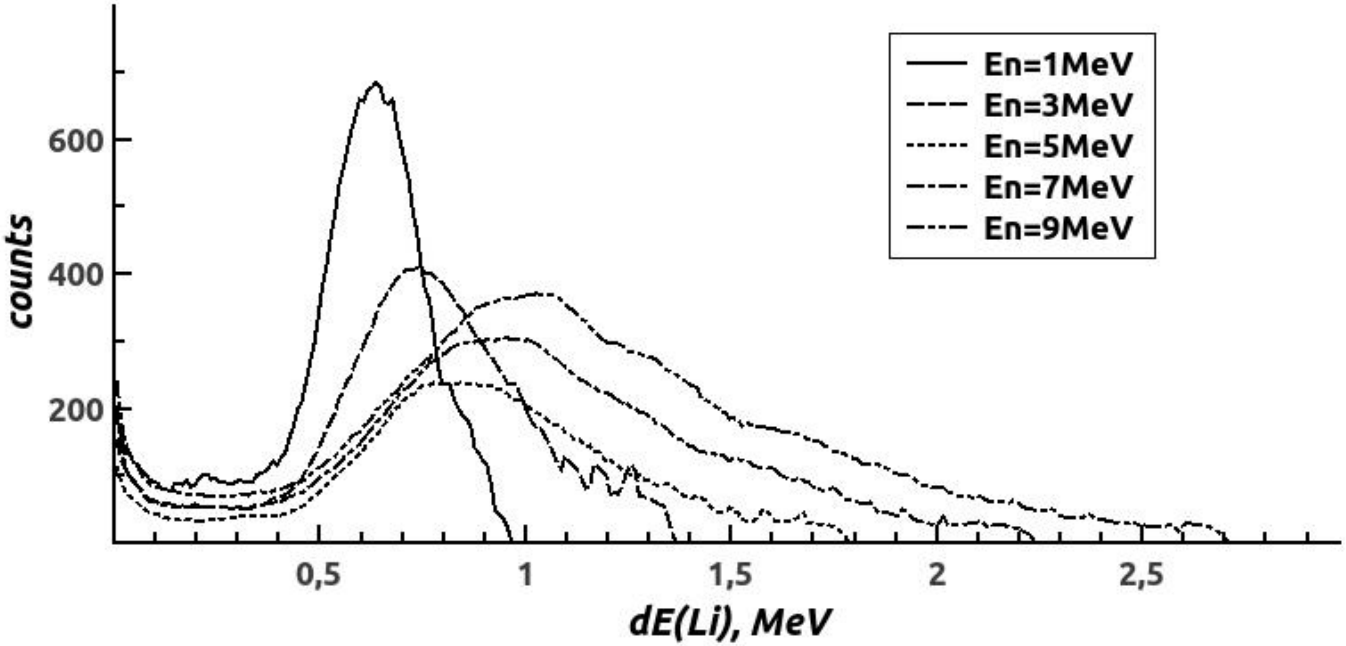
i) Time-of-flight measurement is in available also.

j) Slow neutron measurement is in available also.

Futher development of this detector in presentation of Alexandr Kasparov

Pulse height simulation in 1-st gap, $n + {}^{10}B \rightarrow {}^{4}He + {}^{7}Li$

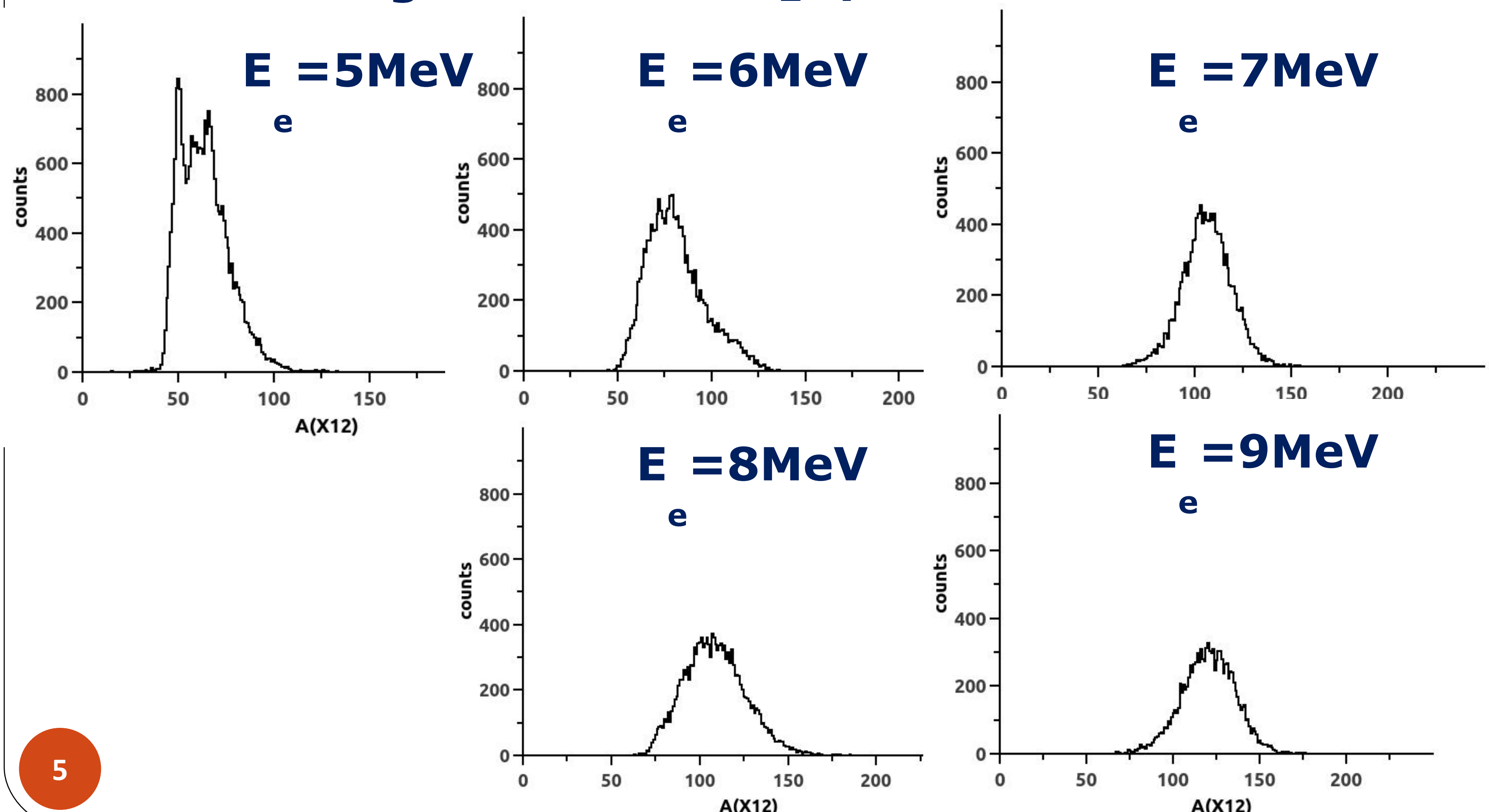
By increasing the detection threshold in the 2-nd gap of the detector, the signal of which served as the trigger, the contribution of events with the ^{4}He nuclei can be suppressed in comparison with the contribution of ^{7}Li.



Pulse height from 1-st , threshold in 2-nd gap is 0.1 MeV

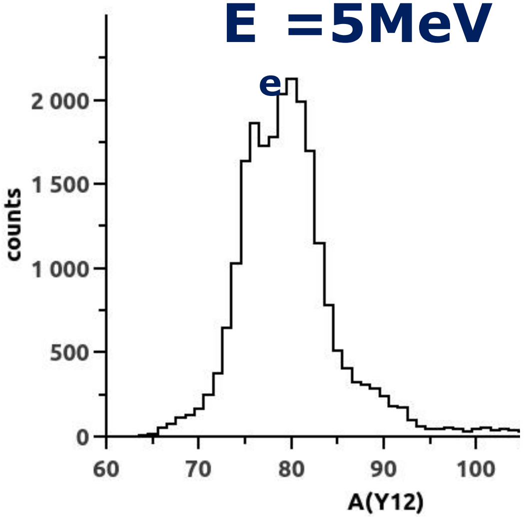
Experiment, pulse height spectra, 1-st gap

Experiments were performed at collimated channel of neutron source based on electron accelerator at from 5 to 9 MeV. The signal of second gap served as the trigger.

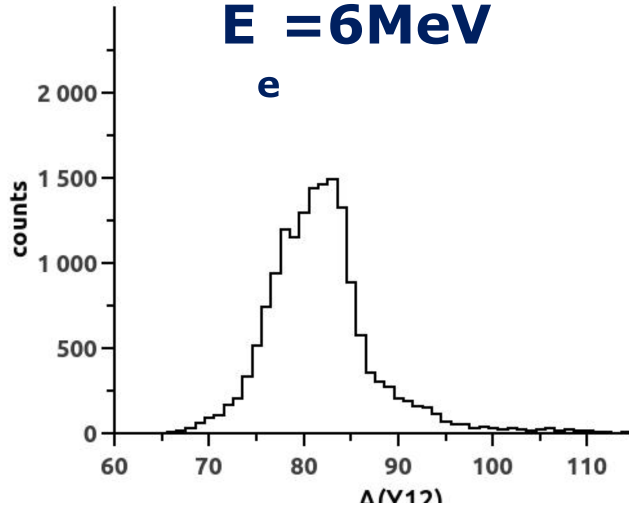


Experiment, pulse height spectra, 2-st gap

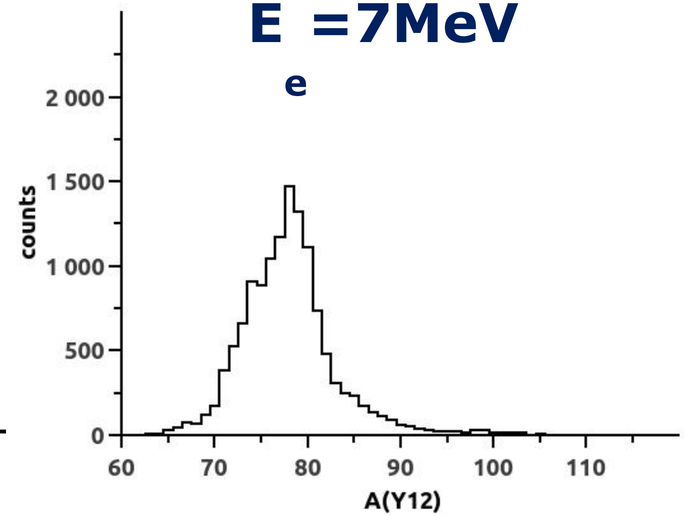
E_e =5MeV



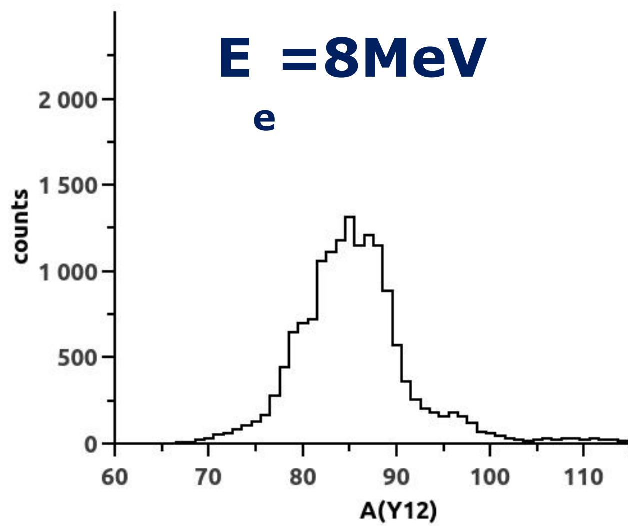
E_e =6MeV



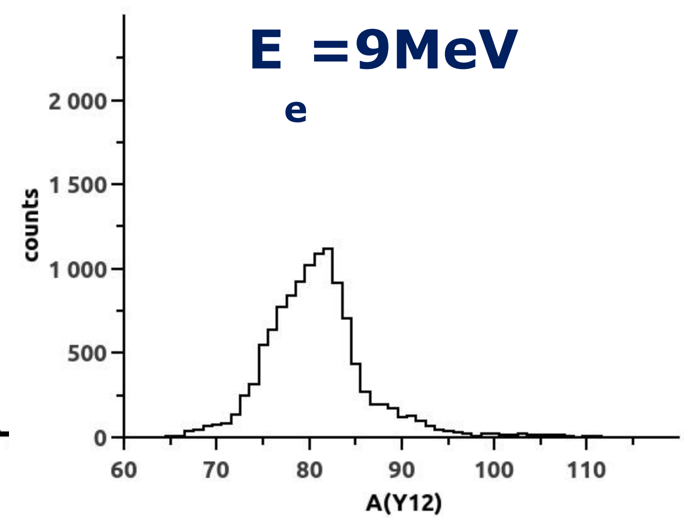
E_e =7MeV



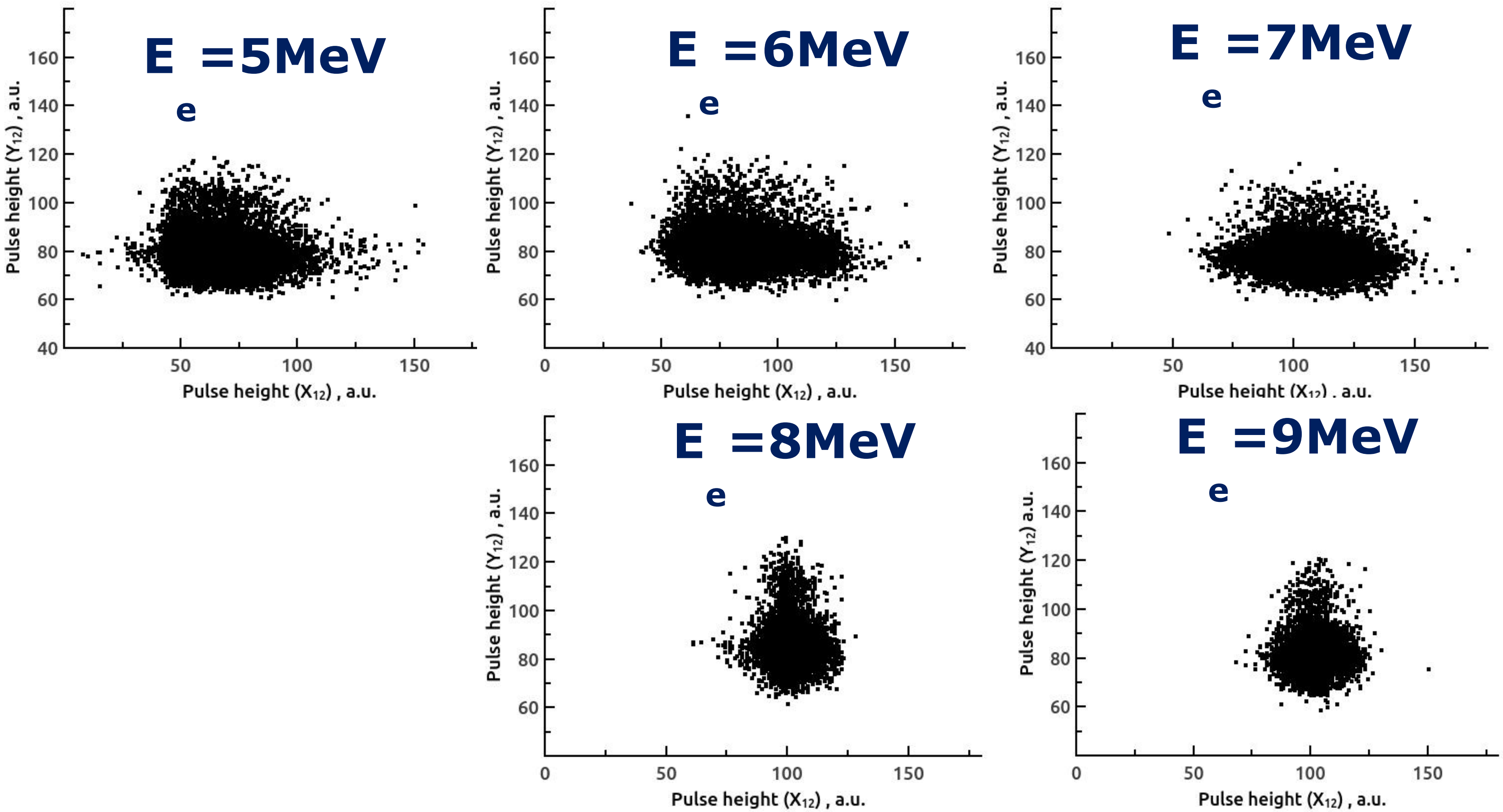
E_e =8MeV



E_e =9MeV

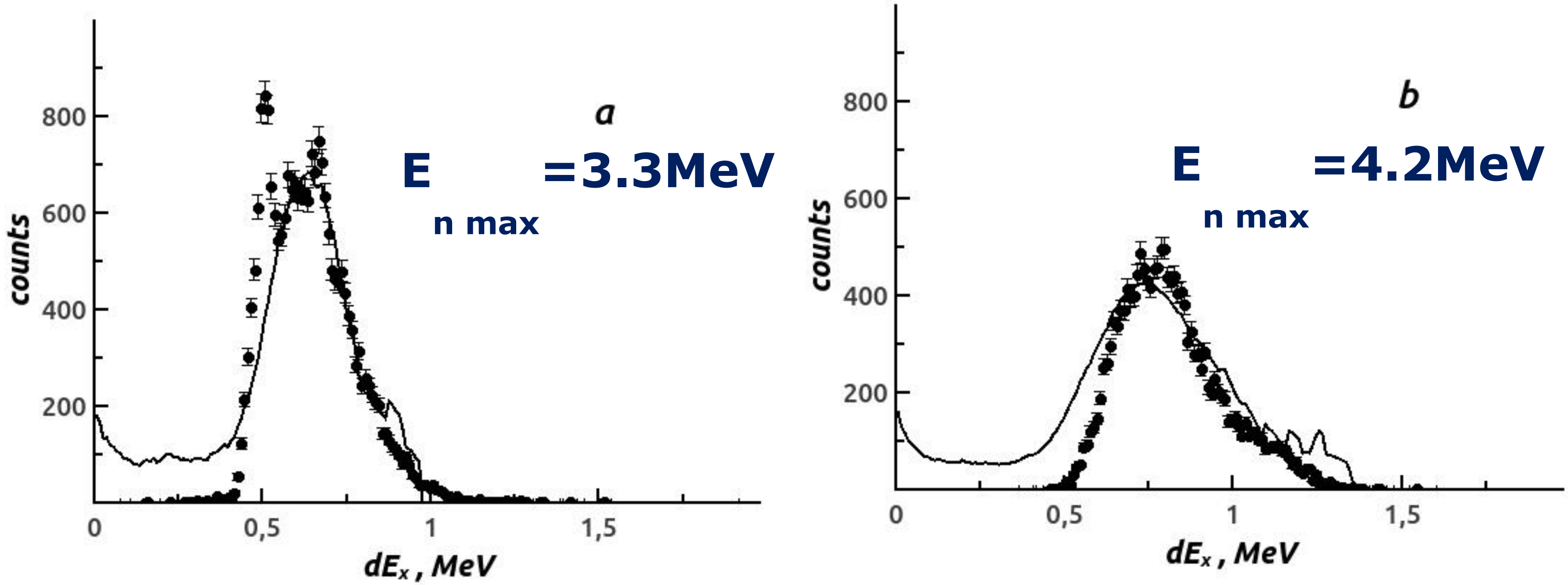


Experiment, pulse heights: 1-st gap versus 2-nd gap



Conversion factor is about 9keV/a.u. Threshold for 2-nd gap is about 0.45MeV. Nuclei ^{7}Li at lower energy $E_{n\,max}$ =5.1MeV (Ee = 7 MeV) almost completely stop in the detector. The nuclei 4He and ^{7}Li penetrate through both gaps at $E_{n\,max}$ =6MeV (E_e =8MeV) and $E_{n\,max}$ =6.9MeV (E_e =9MeV) and they is not completely stopped in the detector.

Comparison of experimental and simulation spectra



$E_{n\,max}$ =3.3MeV **$E_{n\,max}$ =4.2MeV**

$E_{n\,sim}$ =1MeV **$E_{n\,sim}$ =3MeV**

We suppose that reaction throuh the exited $^{11}B^*$ nucleus affects on spectrum at $E_{n\,max}$ =3.3MeV. Direct reaction with the production of ^{4}He and ^{7}Li is also present.

Summary and conclusions

The possibility of control the maximum energy in the neutron flux by analyzing the pulse height spectra of the ^{10}B-detector was investigated. Direct reaction with the production of ^{4}He and ^{7}Li was considered. The ionization loss of nuclei in two detector gaps were calculated. A change in the both experimental and simulated ionization loss spectrum depending on the neutron energy was found.

- Thank you!