Identification of Xe bunch at the JINR Nuclotron-M accelerator by the track length measurement method

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Xe
A=124, Z= +42

http://nucloweb.jinr.ru/:

- setting the Xe beam acceleration (Z=42+, A=124),
- receive beam in the accelerator ring (Ekin ~ 1.5 GeV/n)

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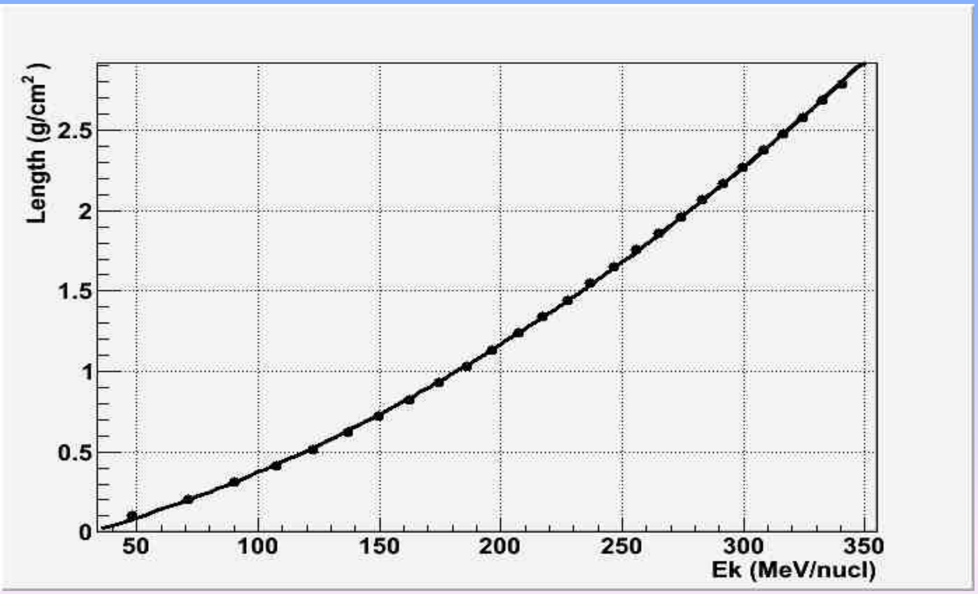
track length measurement method



Dependence ^{124}Xe track length in scintillator on initial kinetic energy (GEANT)

Root-mean-square fluctuation of track length depending on kinetic energy :

$$\sqrt{<(R - <R>)^2>} = \sqrt{\frac{200 m_e}{M}}\, f\left(\frac{E}{M}\right)$$

where R - track lenght, M - particles mass, E - its kinetic energy.
0.03 < f (E/M) < 0.04 (Techniques of High Energy Physics, D.M. Ritson, Interscience Publishers, Inc., New York, 1961).

Xe: E=118MeV/n → 0.11% E=318MeV/n → 0.095%

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Definition of the minimum particle energy

- Change of an absorber thickness at the fixed particle energy
- Energy change at the fixed absorber thickness

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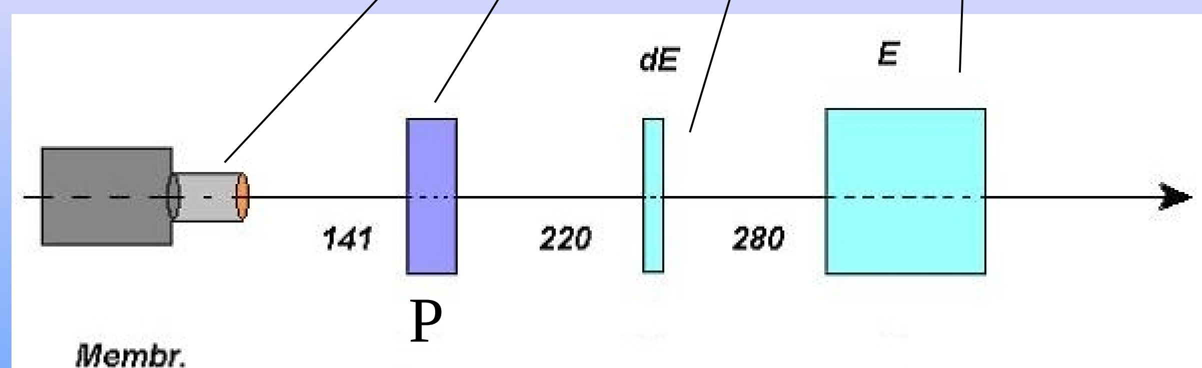
Experimental set-up

Beam particles identification consisted in definition of the minimum energy of particles for passage of an absorber of the fixed thickness dx.

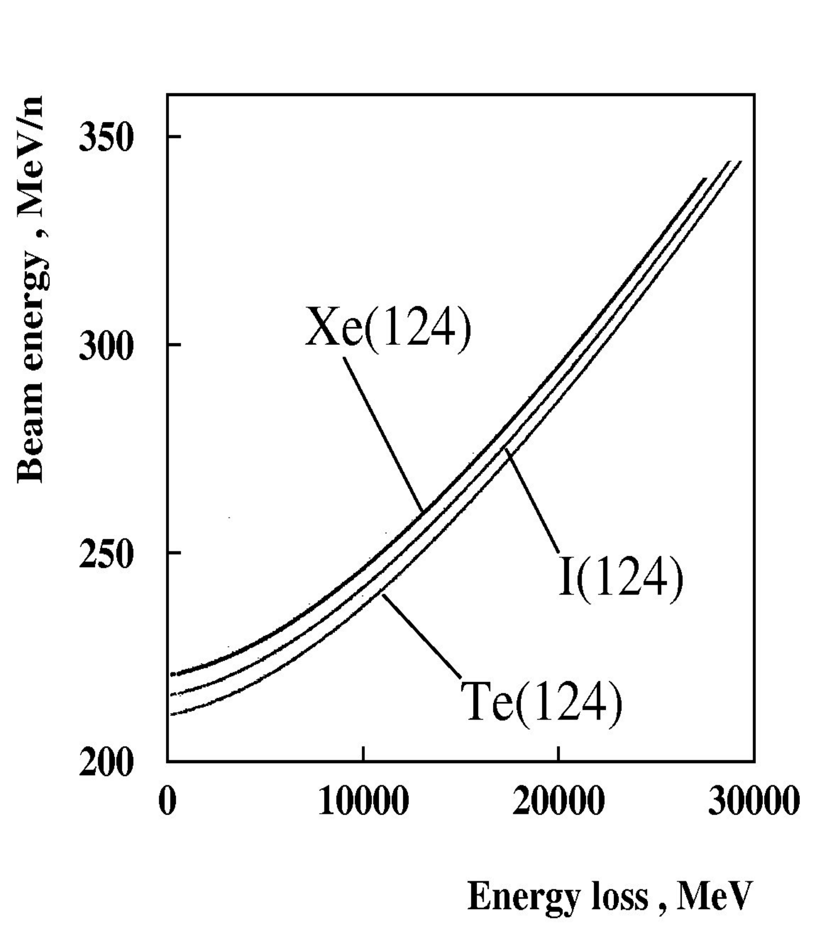
An absorber is substance located in front of E (thickness – 150mm), namely: output Nuclotron membrane in the thickness 200 mkm; scintillator detectors P, dE in the thickness 9мм, 3мм accordingly.

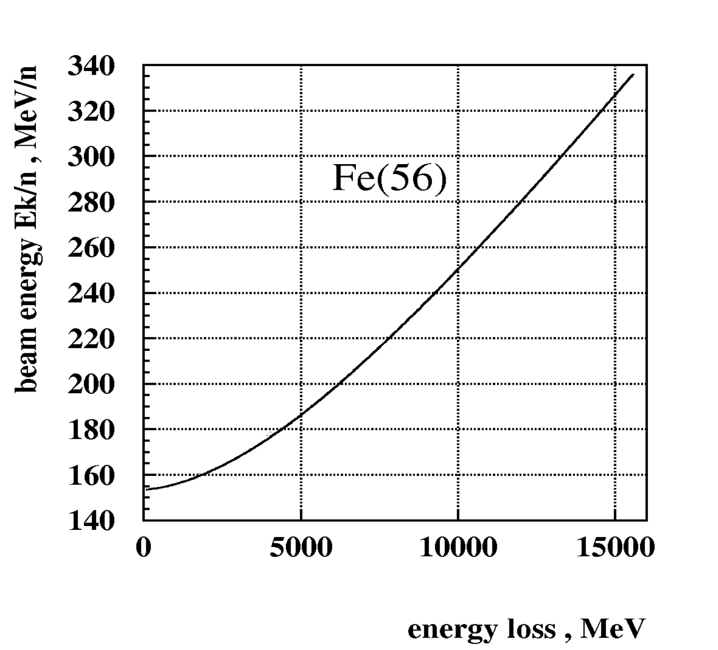
dE was used as the starting detector.

Bmax = 3920 Gs
Eмax = 345 MeV/n



Simulation





Xe(124)	**Emin = 218.08 ± 0.003**	**MeV**
I(124)	**Emin = 214.08 ± 0.007**	**MeV**
Te(124)	**Emin = 209.71 ± 0.007**	**MeV**
Fe(56)	**Emin = 149.57 ± 0.002**	**MeV**

$$v_i > 3 * v_0 * Z^{0.45}$$

McMahan M.A., Lebed R.F., Feinberg B.
LBL-25930-Berkeley, CA: Lawrence Berkeley Nat. Lab., 1989

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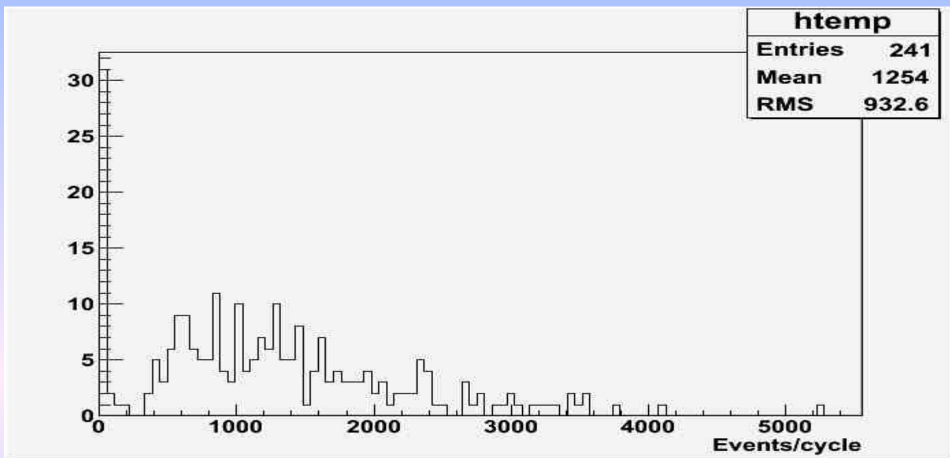
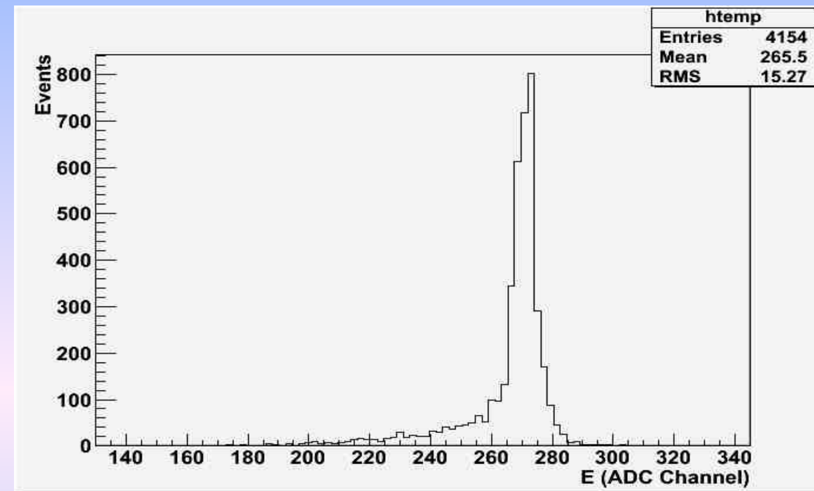
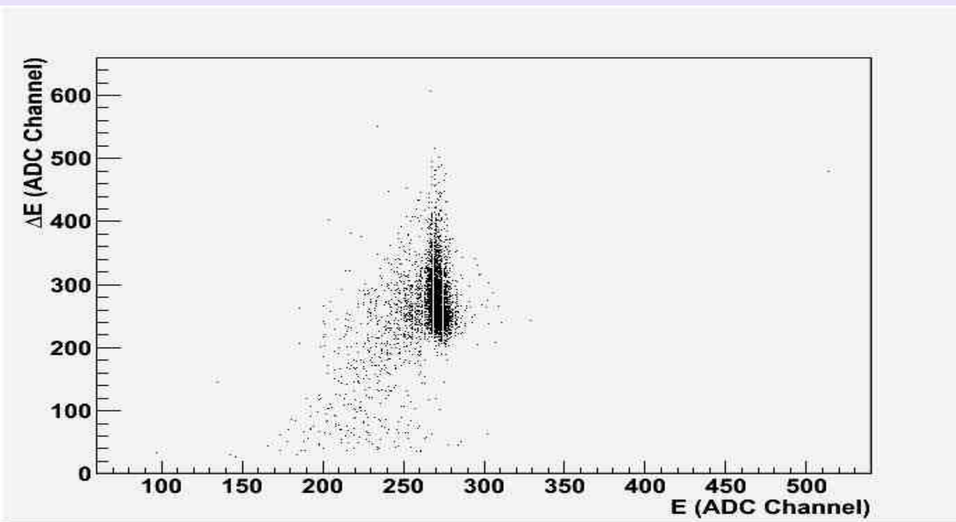
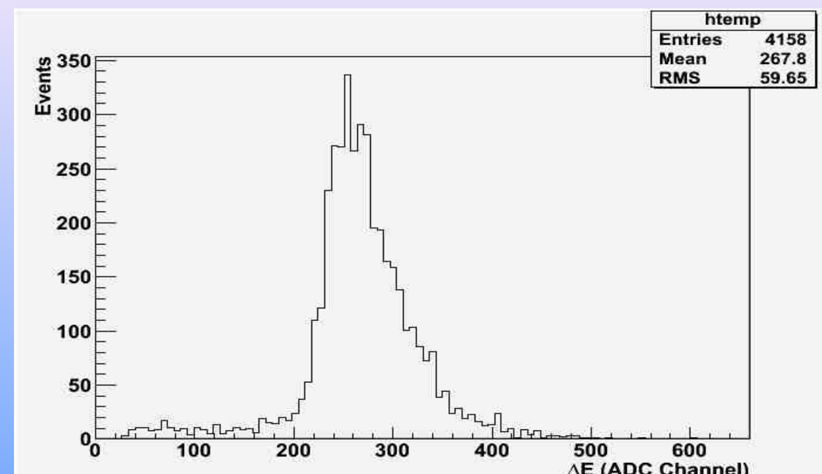
For each event
interaction time, a magnetic field in the accelerator, amplitudes of E and dE signals
was registered.









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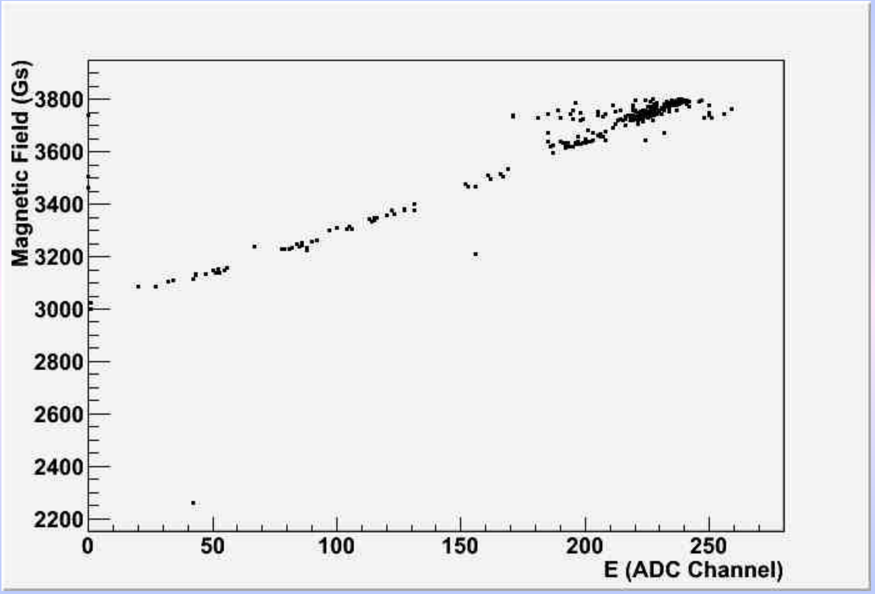
Processing of experimental data

$$E_k = \sqrt{(m_0^2 + (field/10000*299.79*R_0*Z/A)^2)} - m_0$$

R_o=22.0 m - effective radius of accelerator curvature;
Z=42 - ion charge; ;
A=124 - atomic number,
m_o=930.787MeV/c^2



frequency of the accelerating field

$$f = 5*\beta*c/L \qquad L = 251.52m \qquad \beta = \sqrt{d^2/(1+d^2)} \qquad d = c*R*Z/m_0$$

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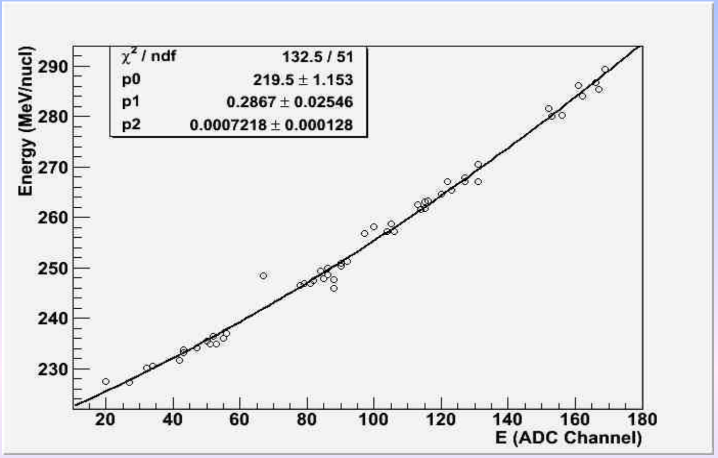
$$E_k = \sqrt{(m_0^2 + (field/10000*299.79*R_0*Z/A)^2)} - m_0$$

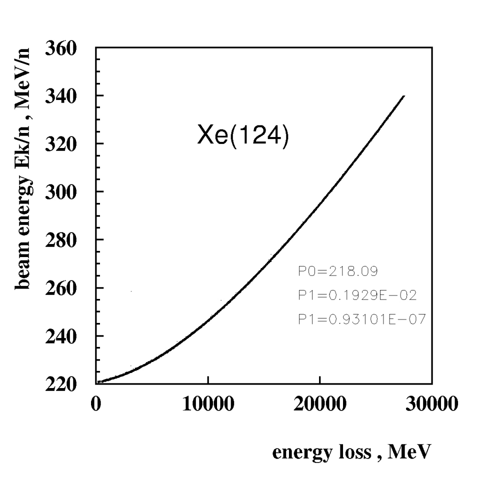
Simulation **Emin=218.08±0.003**

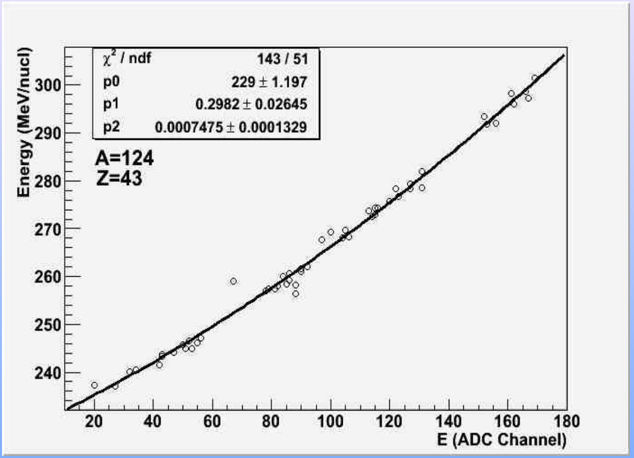
A=124 Z=43 Emin=229.0 ± 1.2

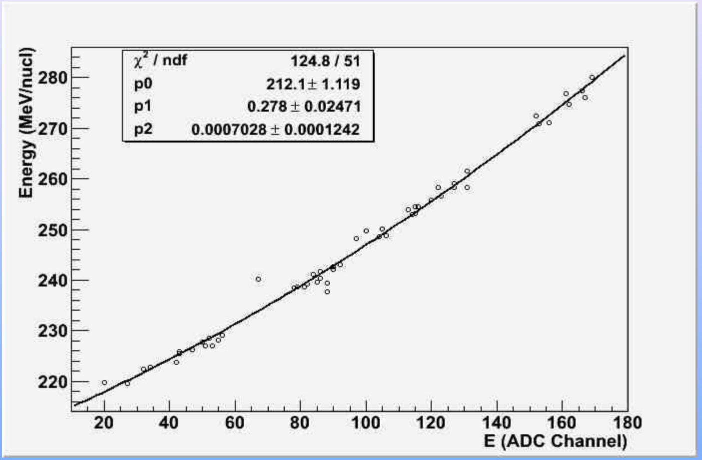
A=124 Z=42 Emin=219.5 ± 1.2

A=124 Z=41 Emin=212.1 ± 1.1









Conclusion

1. The method for fast and exact beam identification in an accelerator operating time is offered.

2. $^{124}Xe^{42+}$ was accelerated in 41th Nuclotron Run.

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Some tasks which are solved in the experiments on the Nuclotron internal target :

Polarimeter
Correlation studies (search for eta-mesic nuclei, ...)
High-resolution magnetic spectrometer
....

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Thank you
for your attention

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