New experimental data for $^{12}C(n,\alpha)^{9}Be$ reaction.

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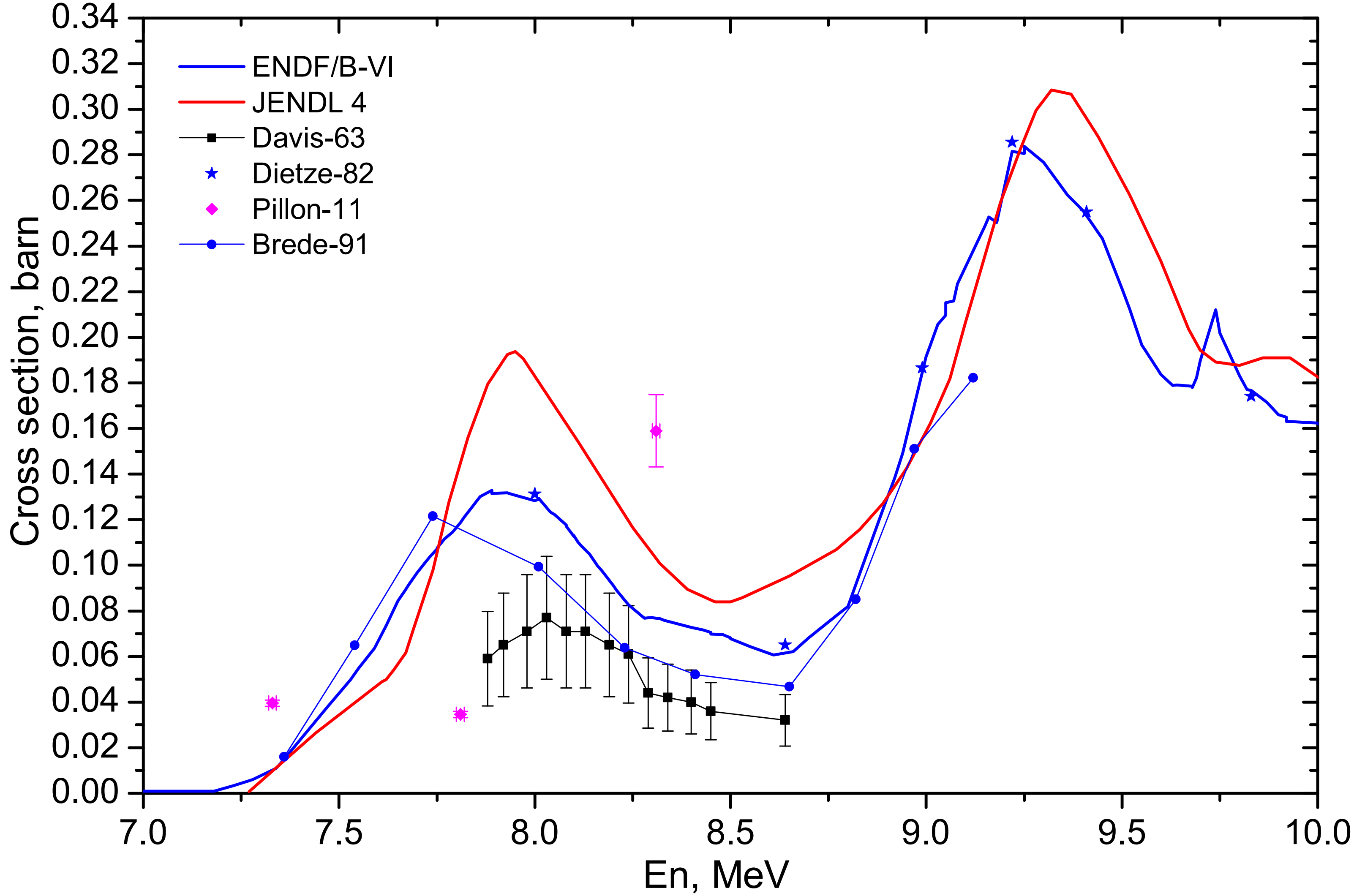
Justification for the $^{12}C(n,\alpha)^{9}Be$ reaction cross section measurement

- Reactor criticality (**graphite moderator, carbide fuel**)
- Dosimetry
- Gas production
- Astrophysics
- Organic scintillator response function.

Current status of $^{12}C(n,a)$ data



Experimental methods for (n,α) reaction investigation

- **Activation method;**
- **Direct measurement of α – particle yield;**

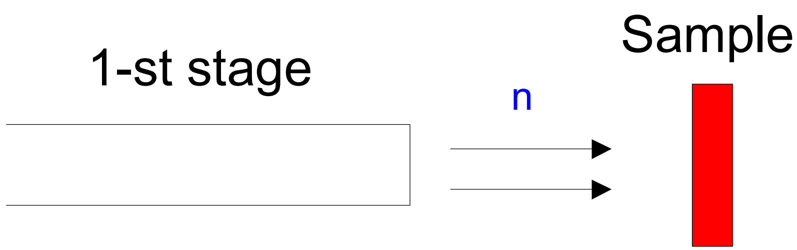
Activation method

$$n + {}^{Z}_{M}A \rightarrow \alpha + {}^{Z-2}_{M-3}D$$

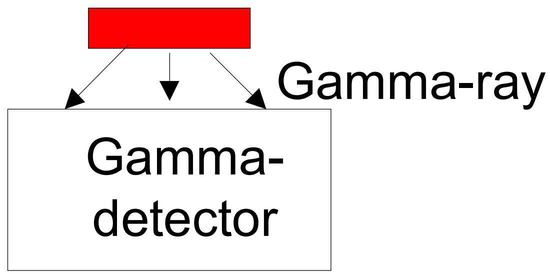
$${}^{Z-2}_{M-3}D \xrightarrow{\beta} {}^{Z-1}_{M-3}N^{*} + \overline{\nu} \qquad , \qquad T_{1/2}$$

$${}^{Z-1}_{M-3}N^{*} \rightarrow {}^{Z-1}_{M-3}N + \gamma$$

1-st stage



2-st stage



Limitations of the activation method

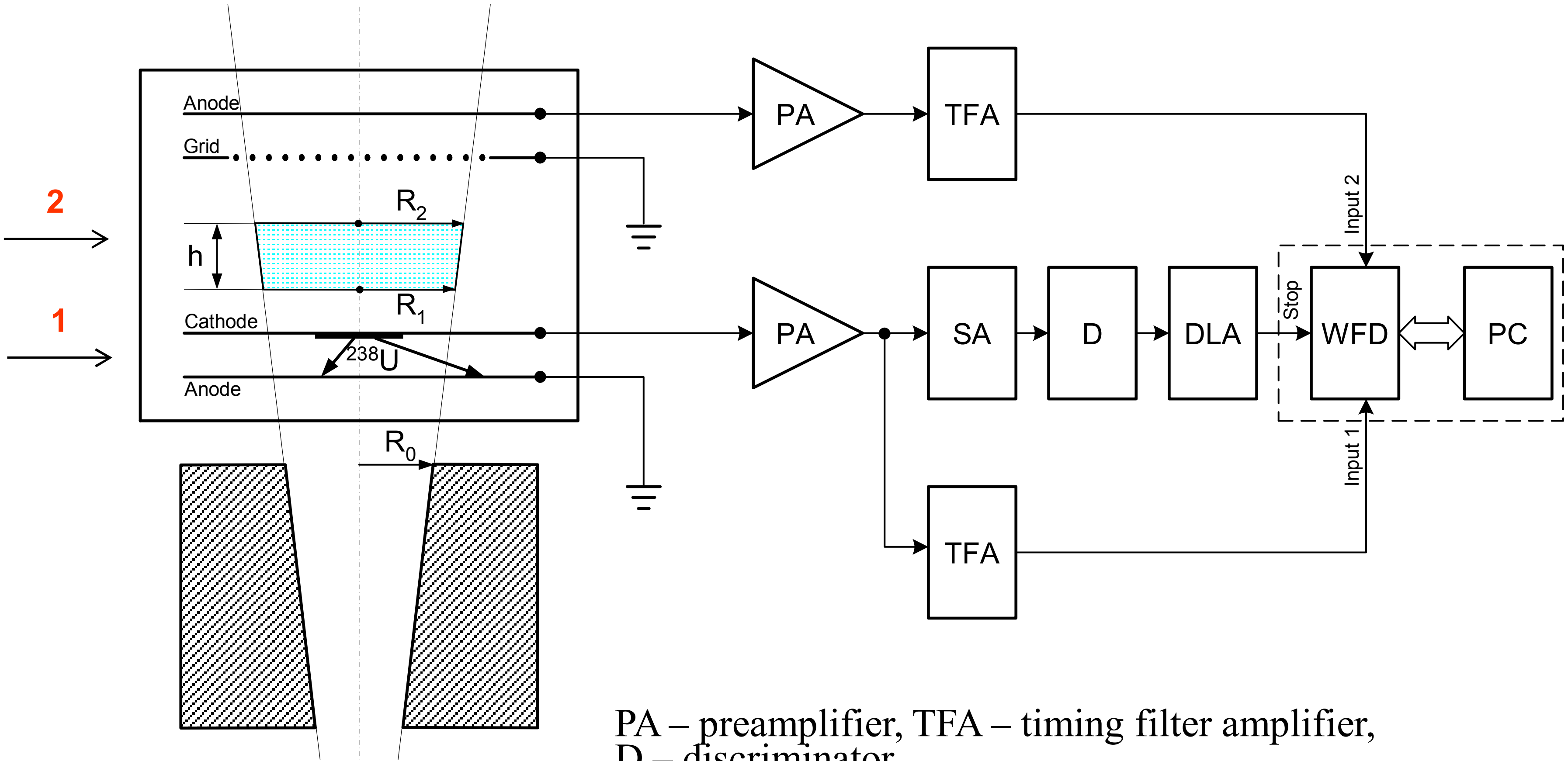
- Residual nuclear must by radioactive!
- Half-life time for residual nuclear must be convenient!
- Energy of gamma-ray must be convenient!
- Yield of gamma-ray must be significant!

For stable residual nuclear activation measurement can not be done at all!

Why is it difficult to measure light elements?

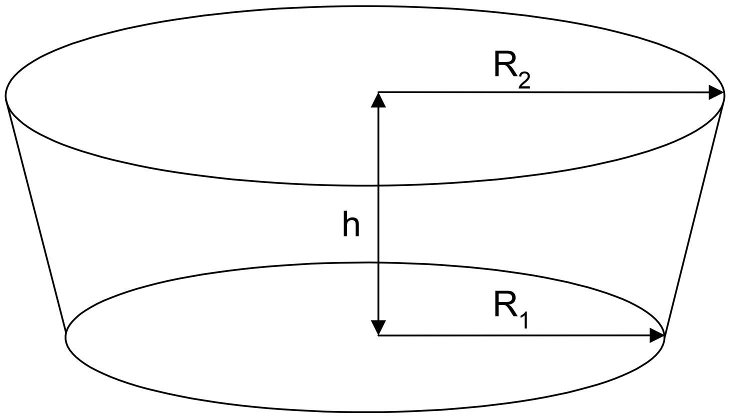
- It is difficult to prepare a clean target
- Low reaction cross section
- The kinematical effect – dependence of anode pulse amplitude from the emission angle.
- Negative Q – value. Background from (n,α), (n,p) reaction, elastic recoil at working gas.
- Background of a detector.
- Light elements from the air (O, N) are present on the electrodes surface.
- Fine structure in cross section.

Scheme of the experimental setup



PA – preamplifier, TFA – timing filter amplifier,
D – discriminator,
SA – spectroscopy amplifier, DLA – delay line amplifier,
WFD – waveform digitizer, PC – personal computer.
1-monitor chamber; 2-main chamber.

Geometry of the gaseous target



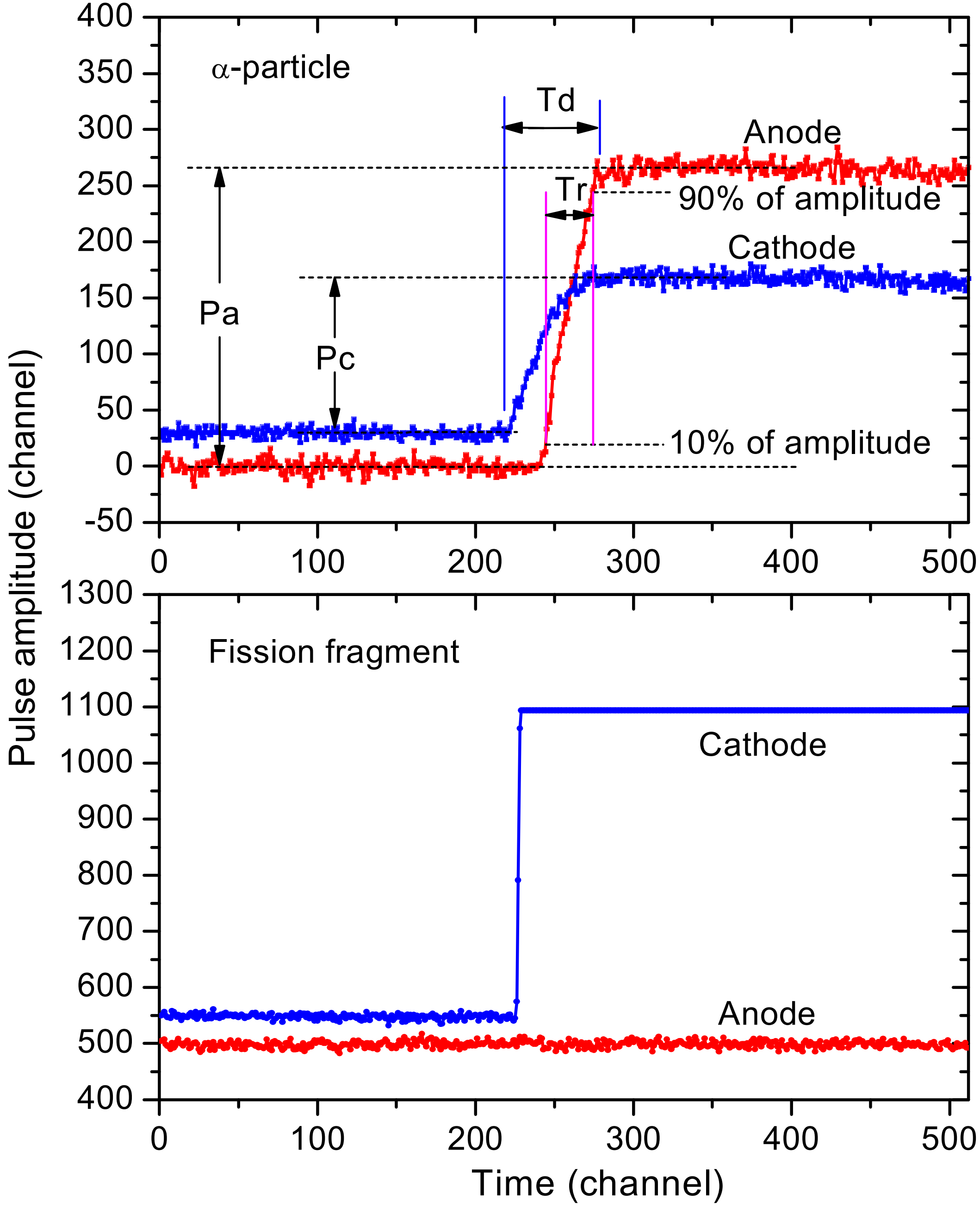
$$V = \frac{\pi h}{3}(R_1^2 + R_1 R_2 + R_2^2)$$

N_{Oxygen}= 2.464*10^{20} nuclei at V=5.6346*10^{-5} m^3

N_{Cfrbon}= 1.232*10^{20} nuclei at V=5.6346*10^{-5} m^3

N(^{238}U) atoms in the monitor= 6.831*10^{18} (solid target ~500 $\mu g/cm^2$)

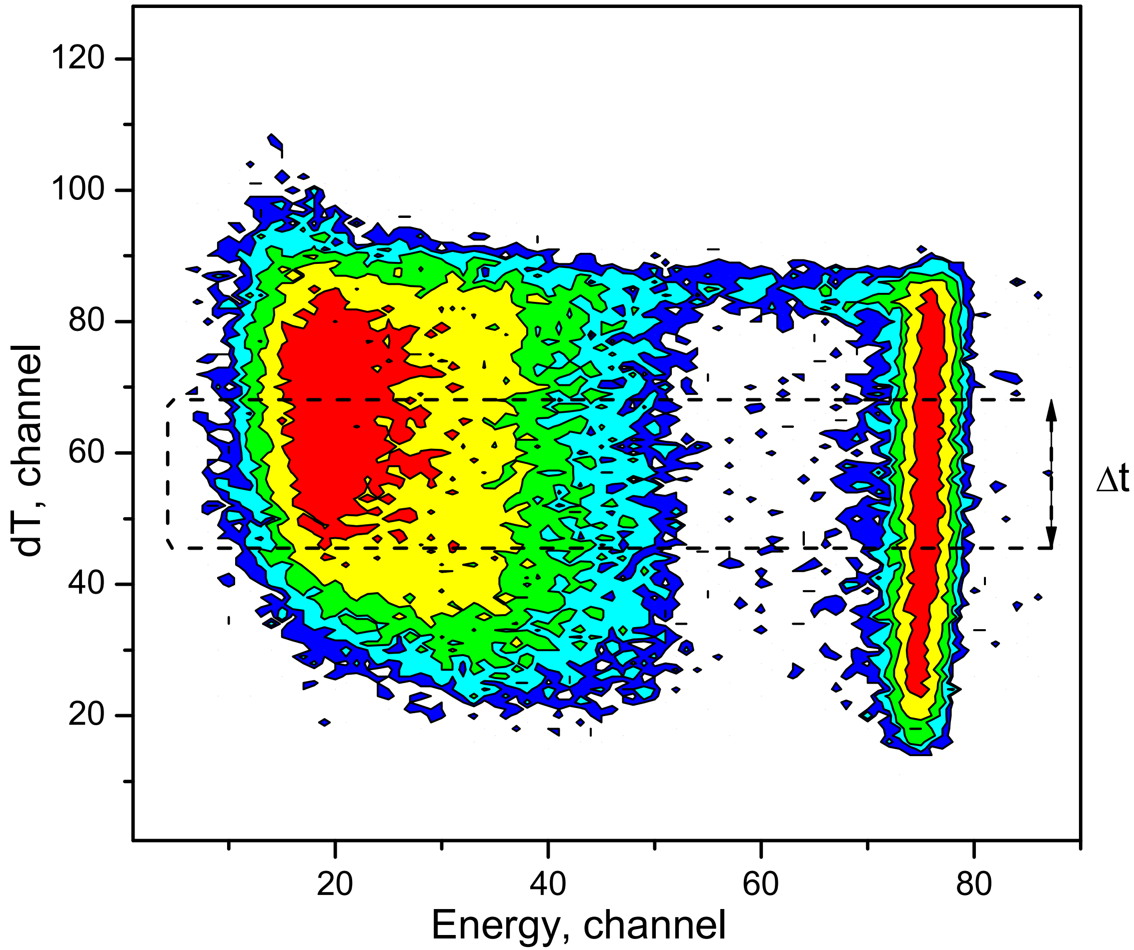
Examples of signals of the main chamber and monitor chamber



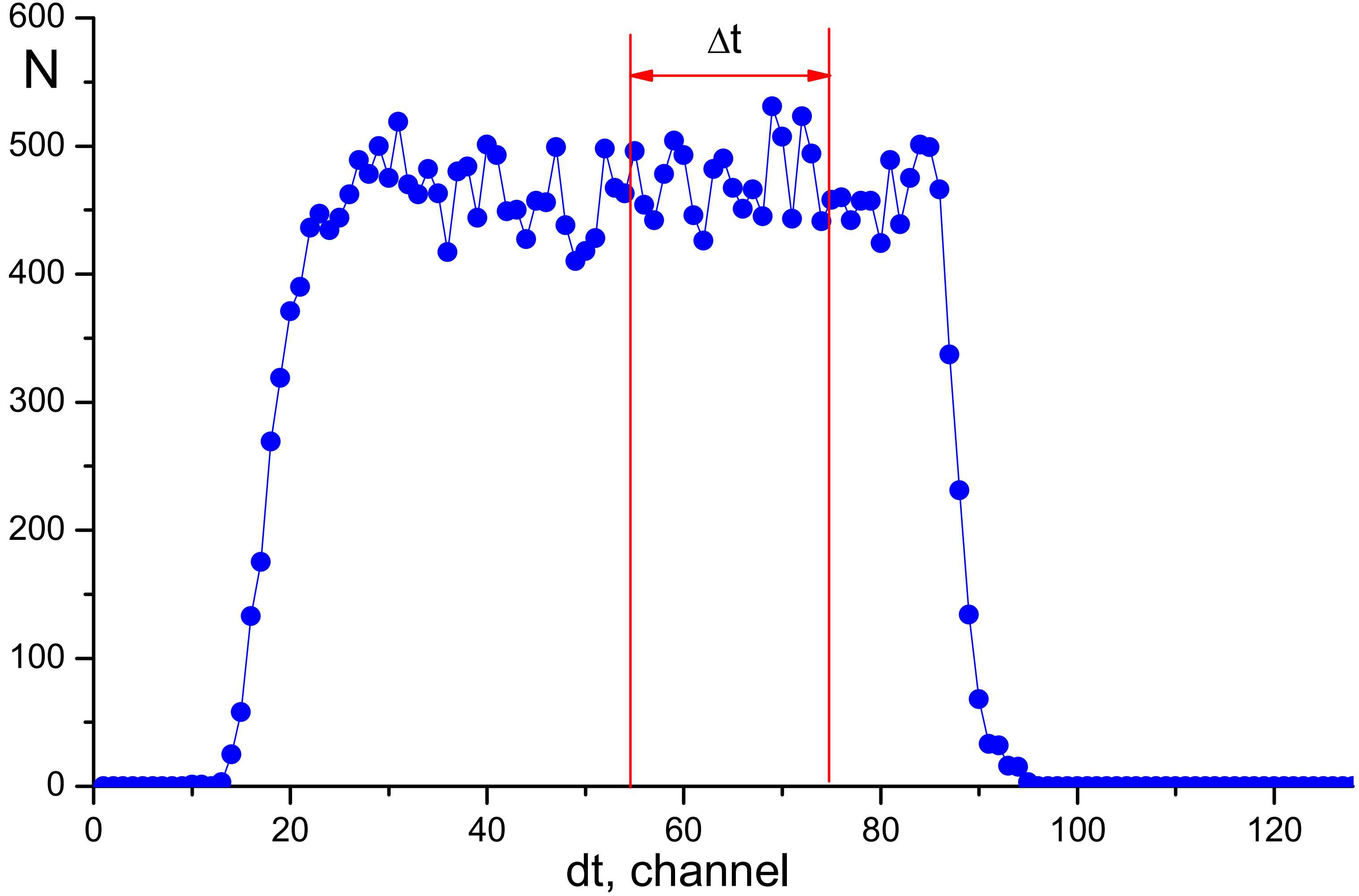
DSP allows you to analyse:

1) Amplitude of anode pulse;
2) Amplitude of cathode pulse;
3) Time when anode signal appeared;
4) Time when anode signal reached the satiation;
5) Time when cathode signal appeared;
6) Time when cathode signal reached the satiation;
7) Ionisation distribution along the particle track. (Anode signal shape).

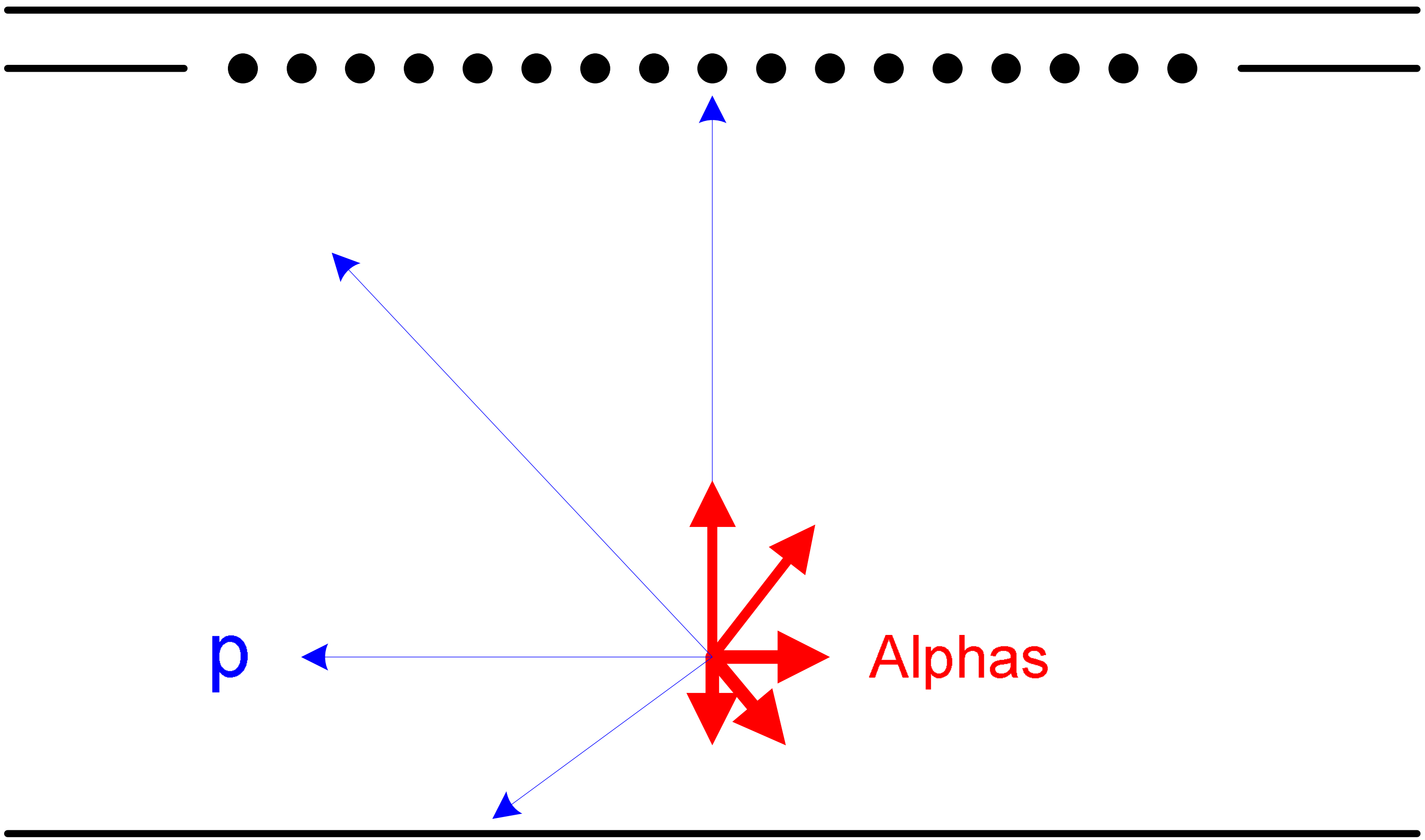
Two-dimensional spectrum of the end of the particle track drift time versus the anode pulse amplitude. The dashed rectangle defines the region of interest for final analysis. The drift time window ΔT_d determines the height of the effective volume of the gaseous target Δx



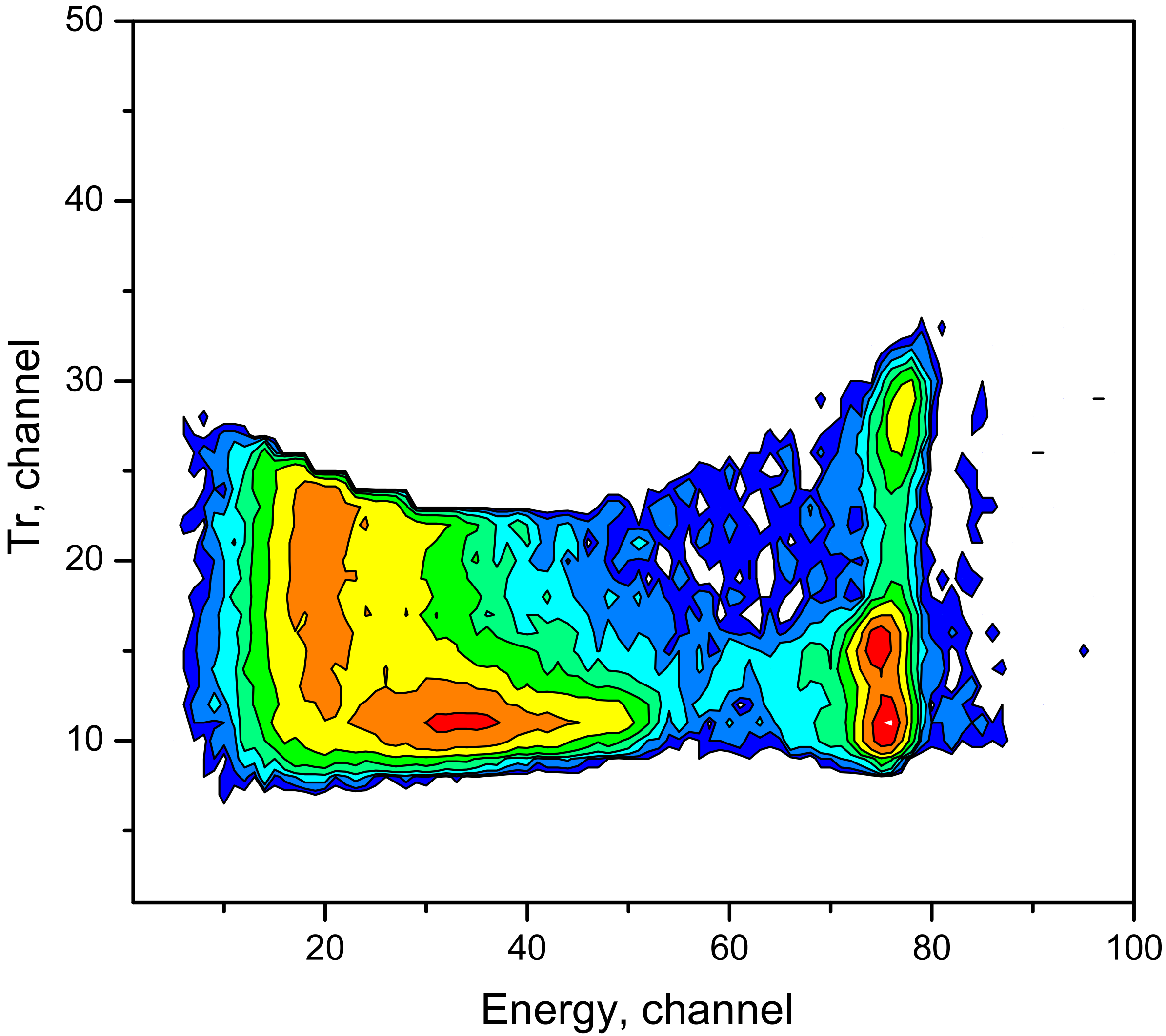
Δt distribution for $^{12}C(n,\alpha)$ α-particles



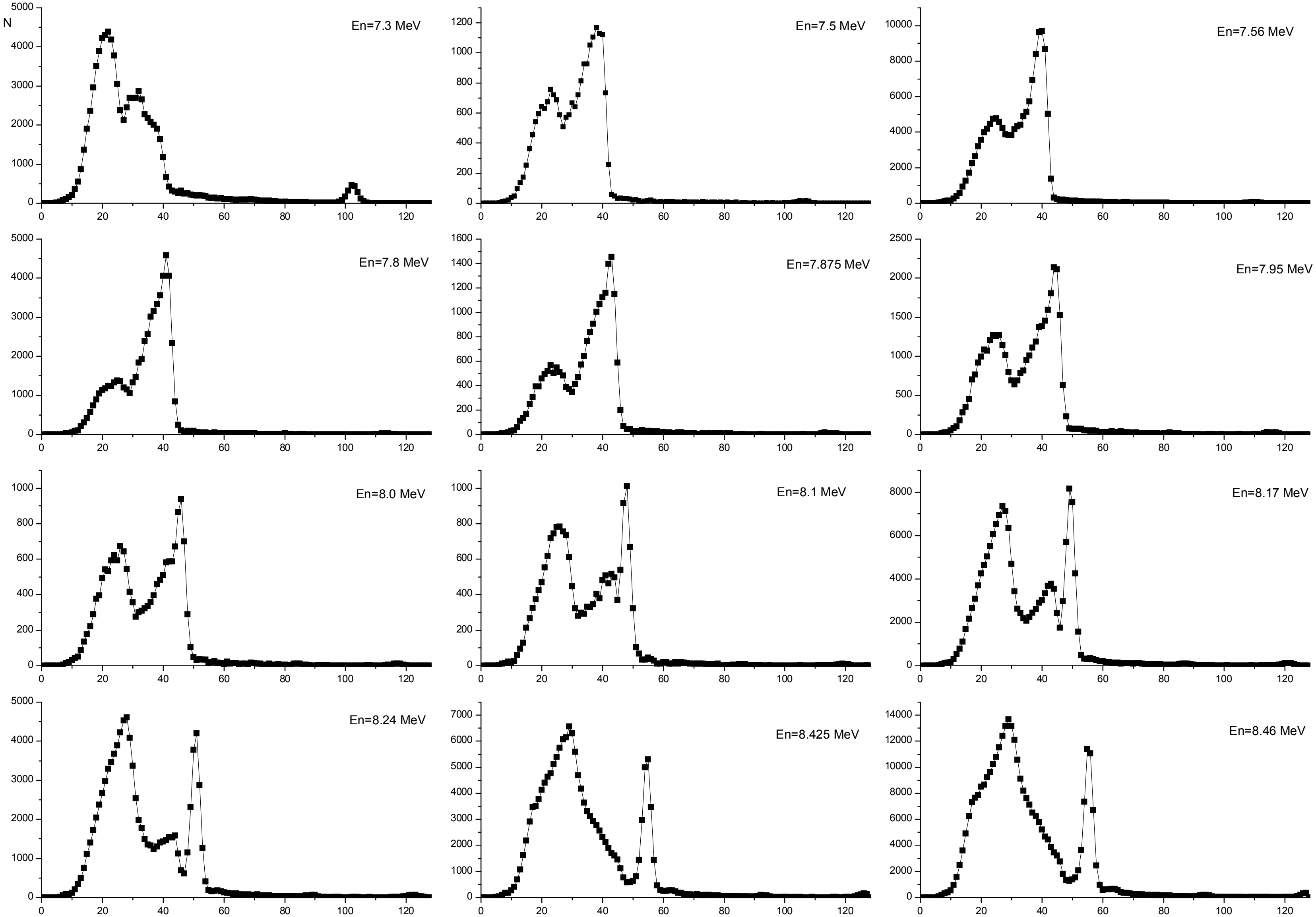
Method of type of particle determination



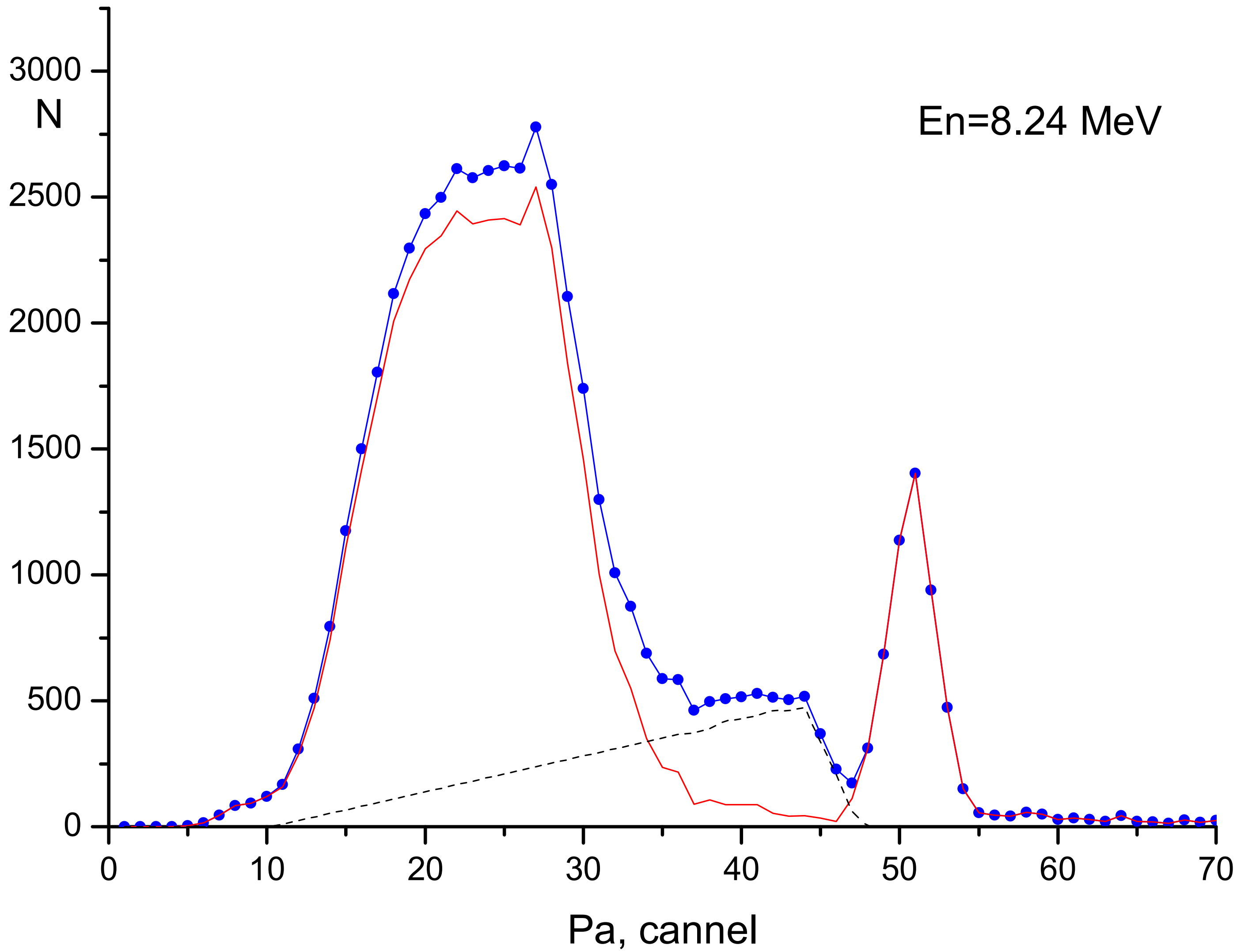
Two-dimensional spectrum of rise time versus anode pulse amplitude with the dashed line separating α particles from background



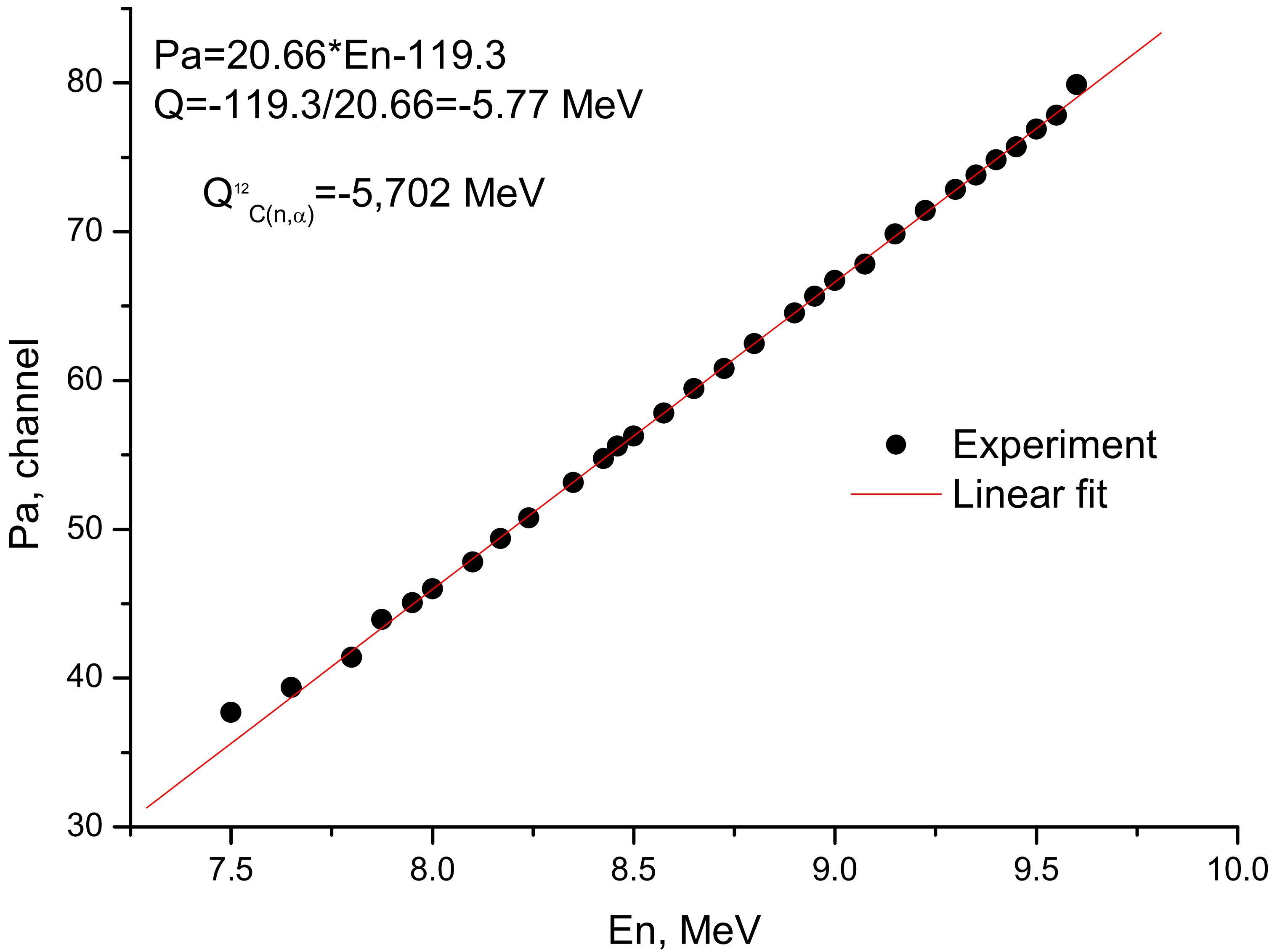
Experimental spectra



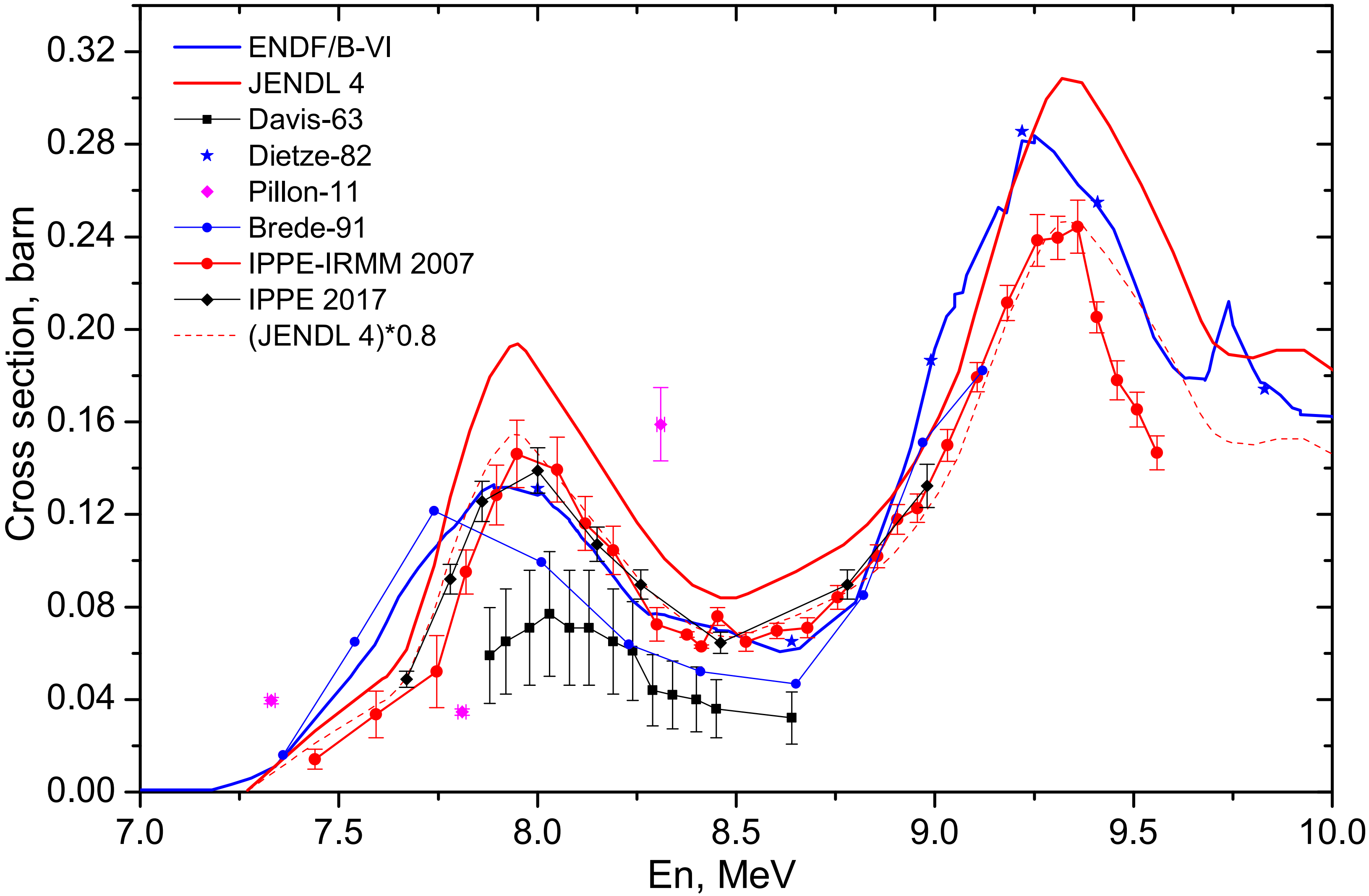
Spectrum decomposition



Peak position dependence



Result



ENDF/B-VI
JENDL 4
Davis-63
Dietze-82
Pillon-11
Brede-91
IPPE-IRMM 2007
IPPE 2017
(JENDL 4)*0.8
Cross section, barn
En, MeV
0.00
0.04
0.08
0.12
0.16
0.20
0.24
0.28
0.32
7.0
7.5
8.0
8.5
9.0
9.5
10.0

Conclusion

- A new data for $^{12}C(n,\alpha)$ reaction was obtained for neutron energy range 7.5 – 9.6 MeV.
- Obtained data is more close to JENDL 3 evaluation (shape of excitation function).
- Normalization 20% is need to have detailed agreement between JENDL 3 and new data.
- Data for neutron energy more then 9.4 MeV have to be analyzed additionally.