THE $^{57}Fe(n,\alpha)^{54}Cr$ REACTION CROSS-SECTION INVESTIGATION FOR NEUTRONS WITH ENERGY LESS THEN 7 MeV.

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IPPE (n,α) reaction cross-section measurements

Light isotopes: $^{10}B(n,\alpha)^{7}Li$, $^{10}B(n,t)2\alpha$, $^{14}N(n,\alpha)$, $^{16}O(n,\alpha)$, $^{19}F(n,\alpha)$, $^{20}Ne(n,\alpha)$, $^{36,40}Ar(n,\alpha)$

Structural materials: $^{50,52}Cr(n,\alpha)$, $^{58}Ni(n,\alpha)$

Justification for the iron c isotopes measurement

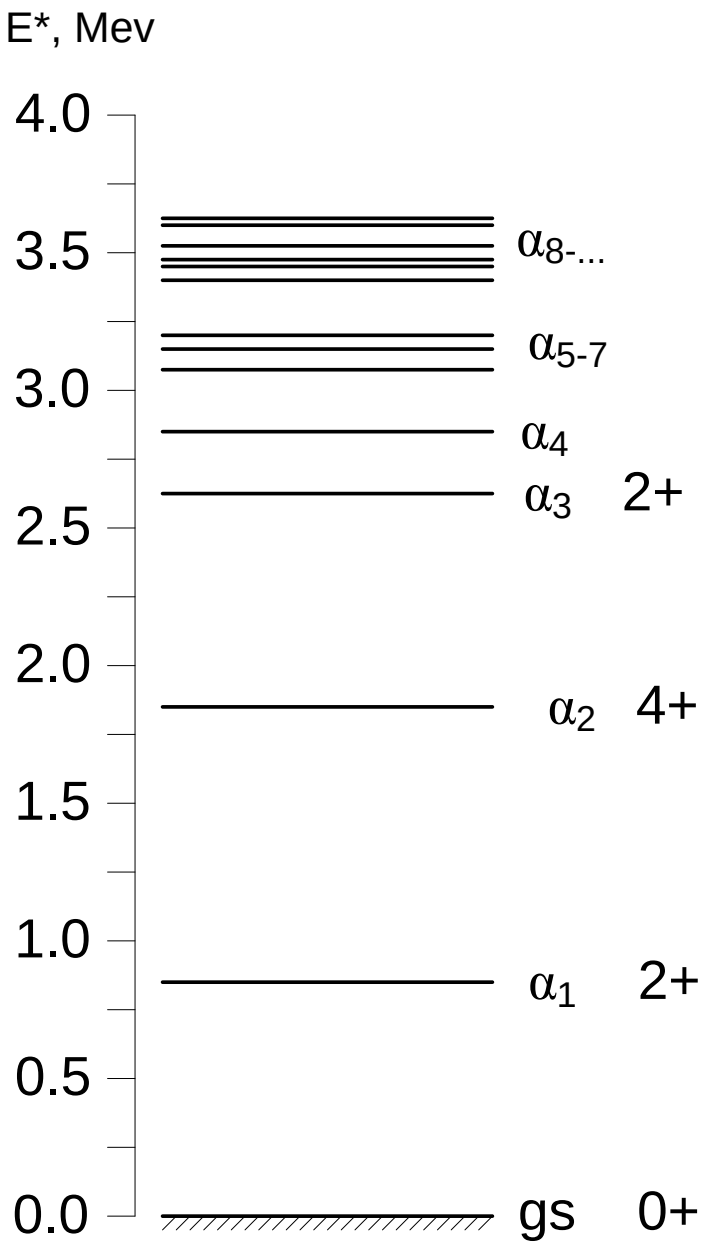
Calculation of helium production in -

- **fuel-element cladding;**
- **Material of reactor vessel;**
- **reactor core;**
- **Other construction contacted with neutron flux.**

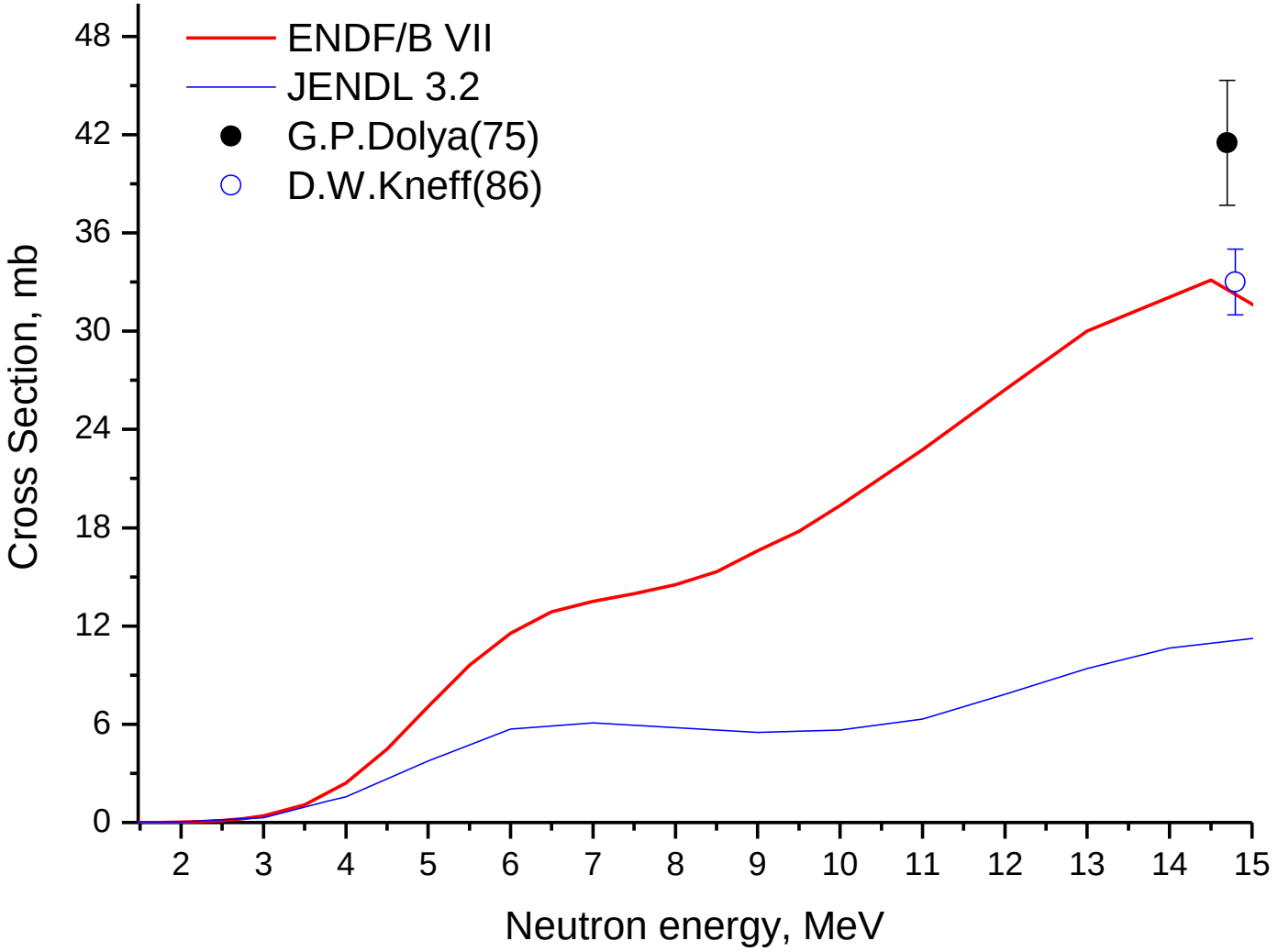
Iron isotopes properties

Isotope	**Natural abundance, %**	**(n,α) reaction Q-value, MeV**
^{54}Fe	5,81	+0,842
^{56}Fe	91,75	+0,326
^{57}Fe	**2,15**	**+2,398**
^{58}Fe	0,29	- 1,399

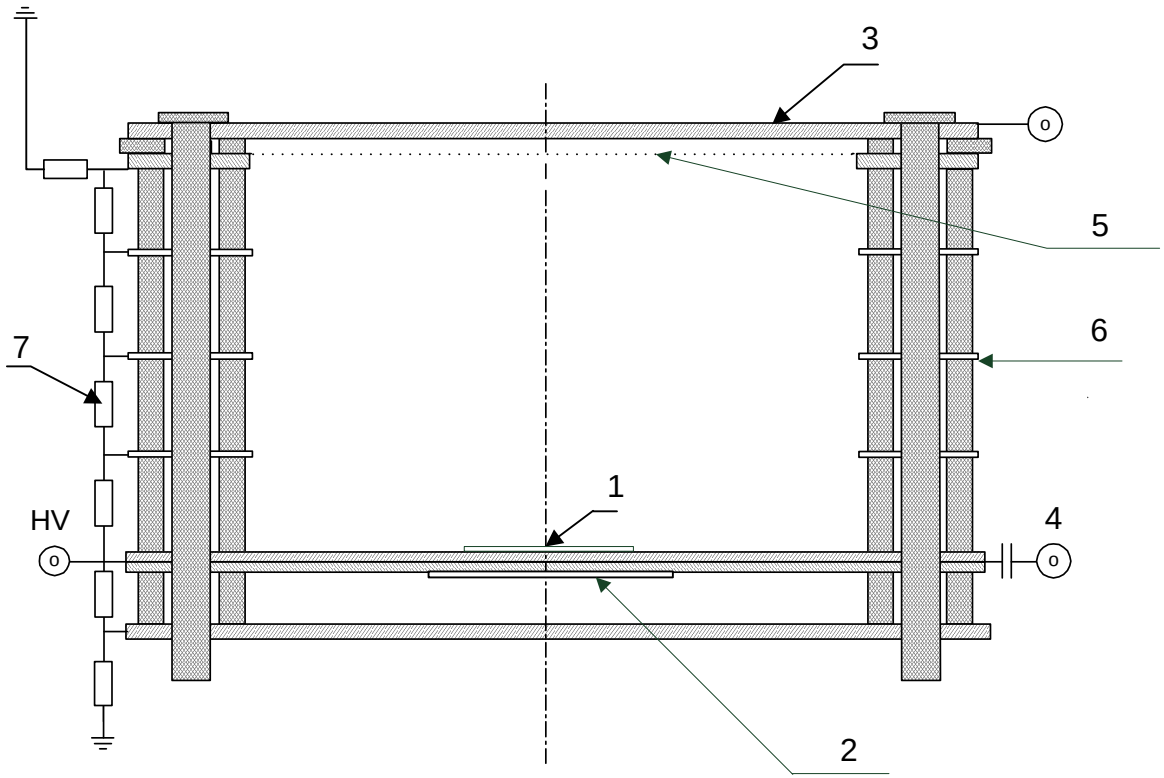
^{54}Cr exited states



Present status of experimental data and evaluation for $^{57}Fe(n,\alpha)^{54}Cr$ reaction

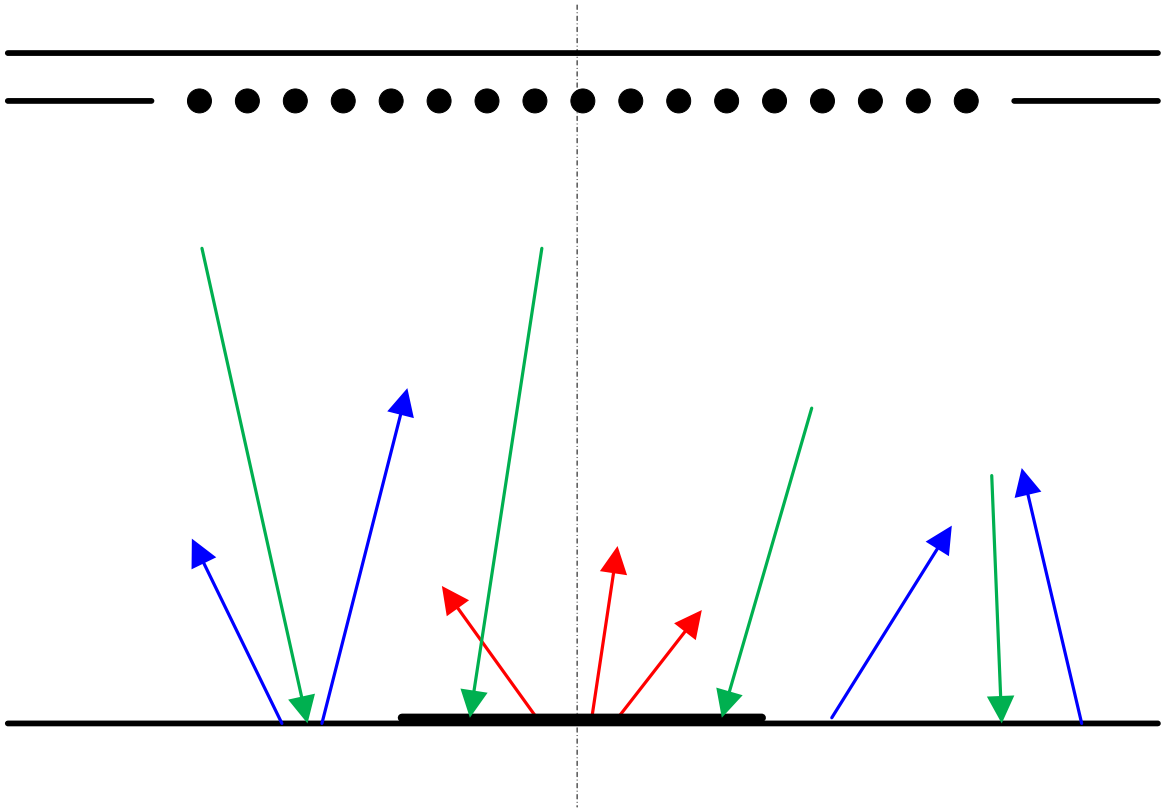


Classical ionisation chamber

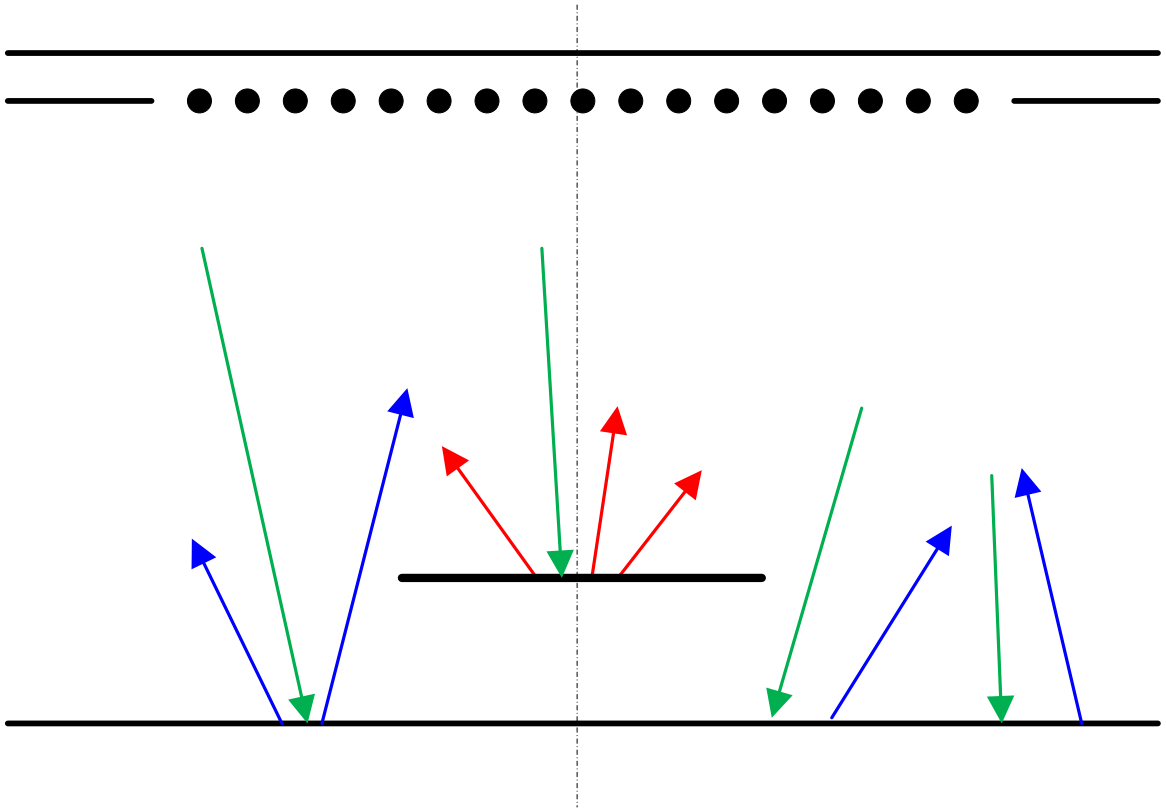


1) ^{57}Fe target;
2) ^{238}U target;
3) Anode;
4) Anode signal connector;
5. Frisch greed;
6. Guard electrodes;
7. Resistor.

Background sources for solid target

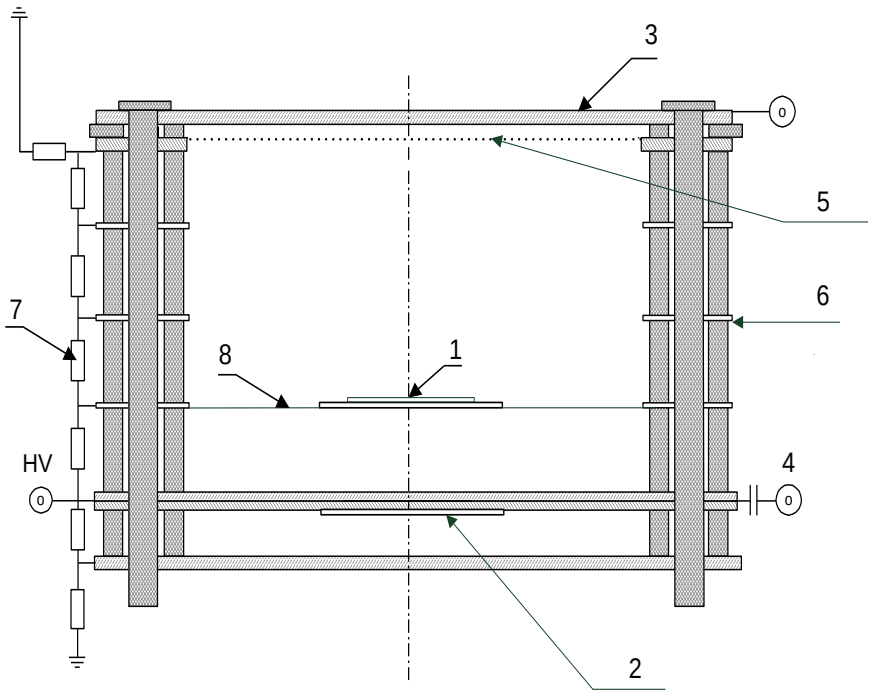


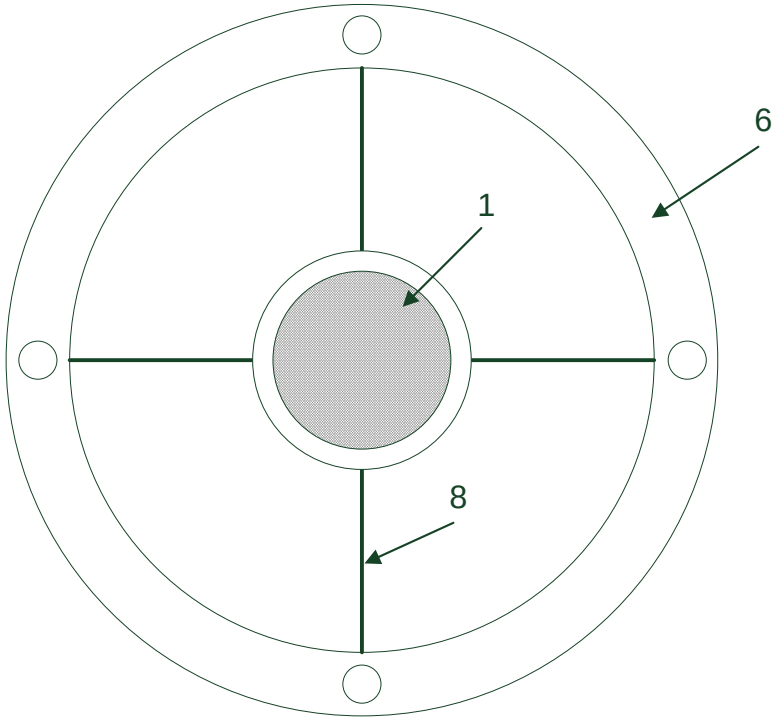
Motivation for removing solid target from cathode surface



1) **Target surface 10 times less then cathode surface;**
2) **Target - thin self-supported ^{57}Fe foil;**
3) **Probability to gaseous particle absorption proportional to electrode surface.**

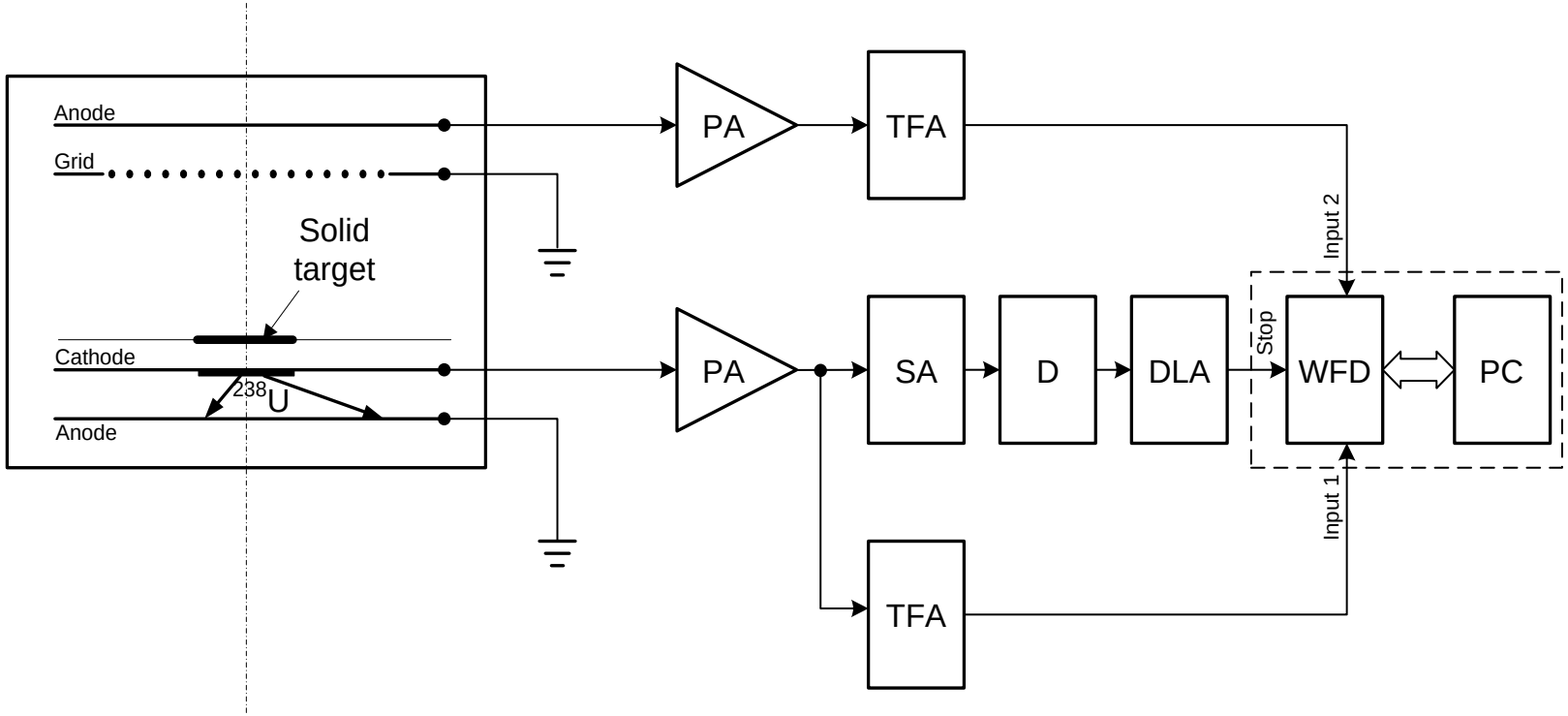
New chamber design.





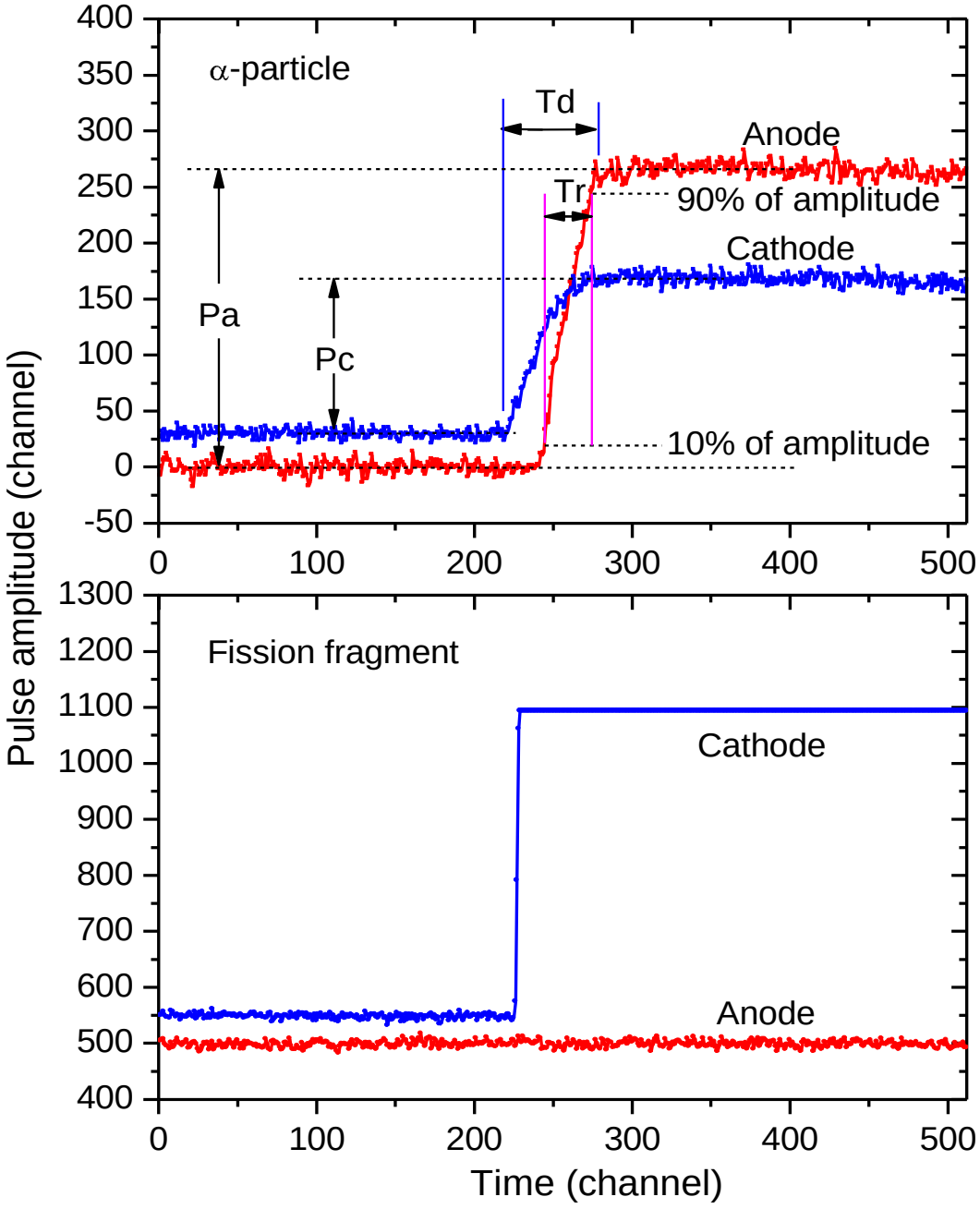
1) ^{57}Fe target;
2) ^{238}U target;
3) Anode;
4) Anode signal connector;
5. Frisch greed;
6. Guard electrodes;
7. Resistor.
8. Golden threads

Signal processing



PA – preamplifier, TFA – timing filter amplifier,
D – discriminator,
SA – spectroscopy amplifier, DLA – delay line amplifier,
WFD – waveform digitizer, PC – personal computer.

Examples of signals of the main chamber and monitor chamber



DSP allow you to analyse:

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

^{57}Fe target

Thin self-supported ^{57}Fe foil

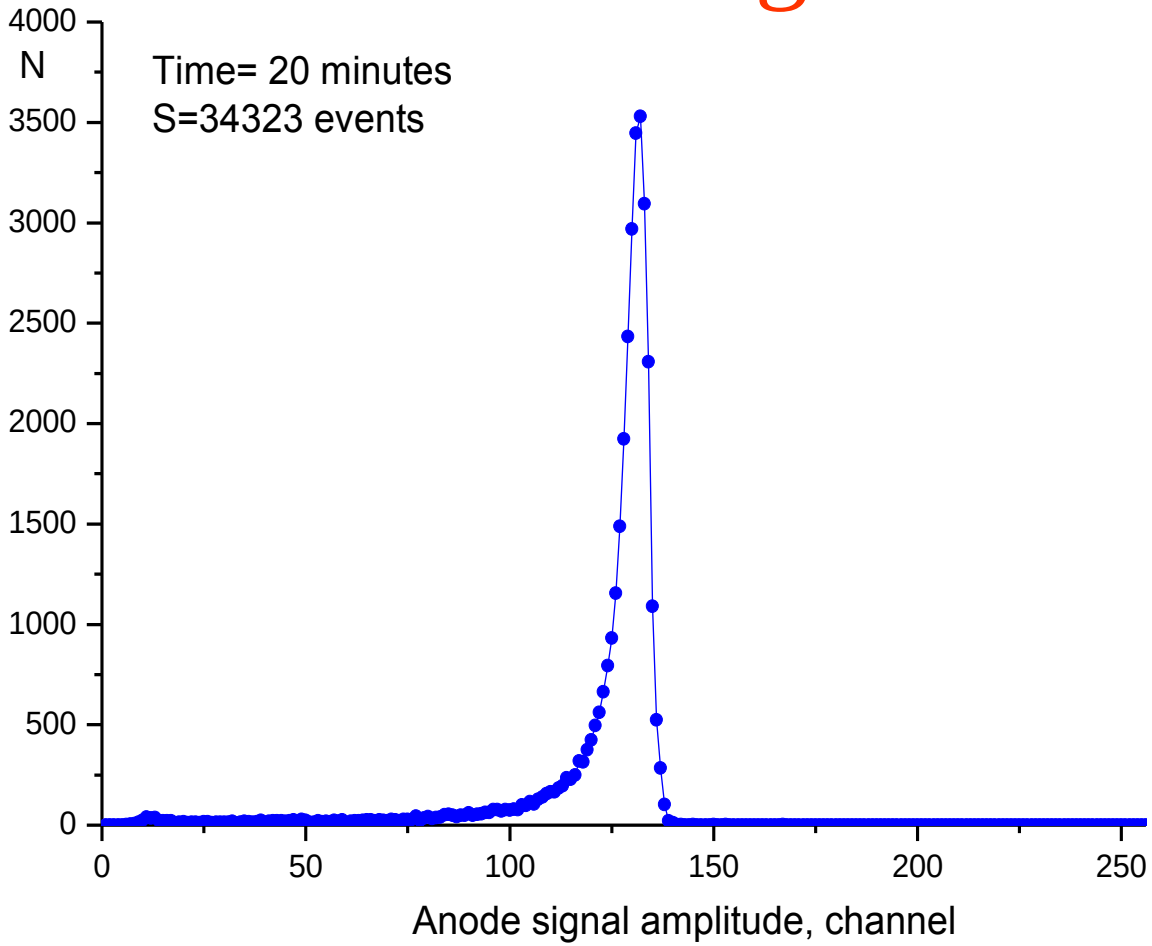
^{57}Fe target foil – (3,55±0,26)*10^{18} at/cm^2 (0,33 mg/cm^2)

Target size – 12x24 mm (Area – 2,64 cm^2);

^{16}O in the target – (0,33±0,04)*10^{18} at/cm^2.

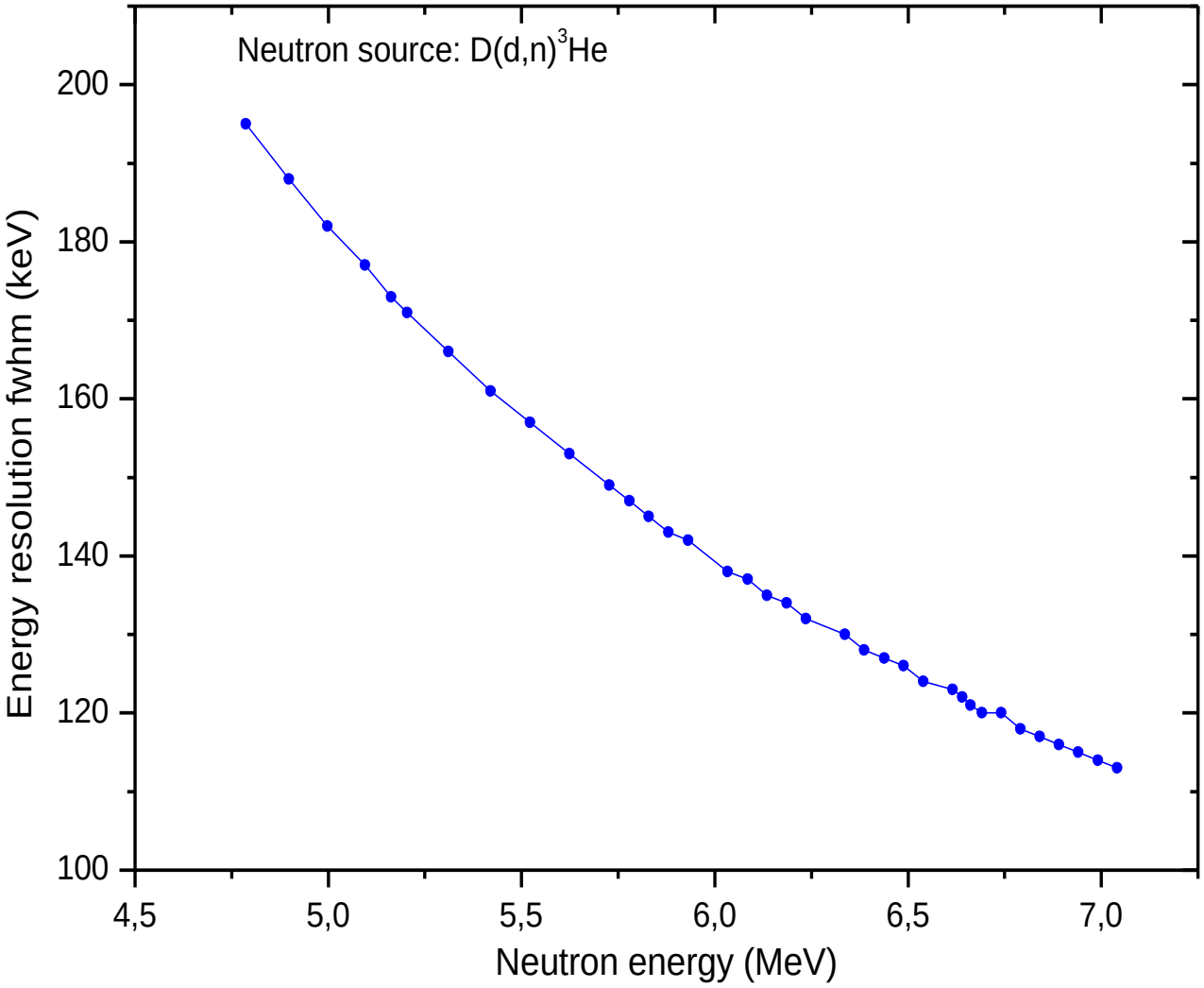
Total mass of ^{57}Fe is 2.1 mg.

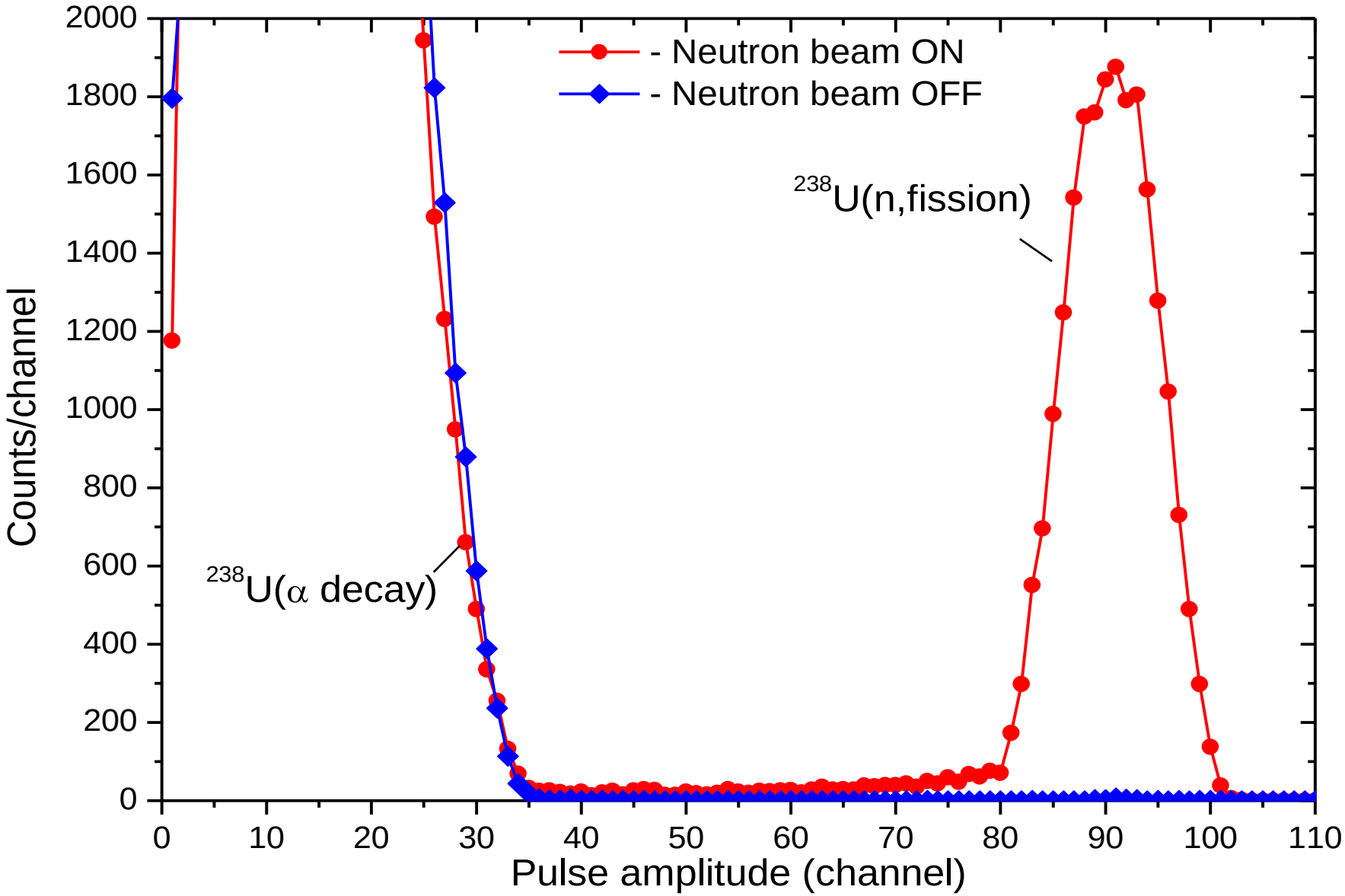
^{238}U target



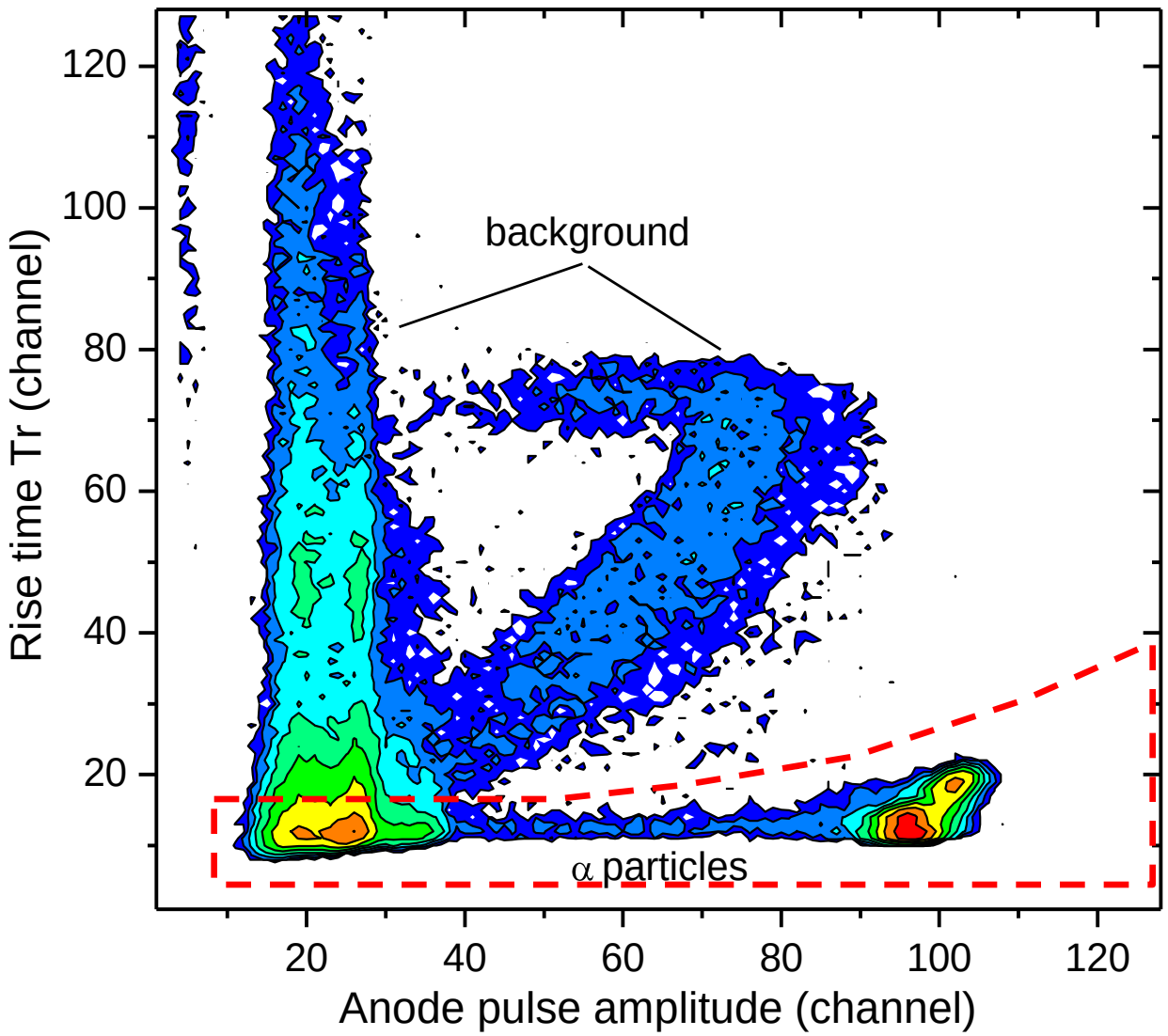
- **Stainless steel backing**
- **^{238}U enriched to 99,99 %**
- **Total ^{238}U mass – 4,598 mg**
- **Total ^{238}U number of atoms – 1,167*10^{19}**

Neutron source
EG-1 accelerator
(d,d) reaction En=4-7 MeV

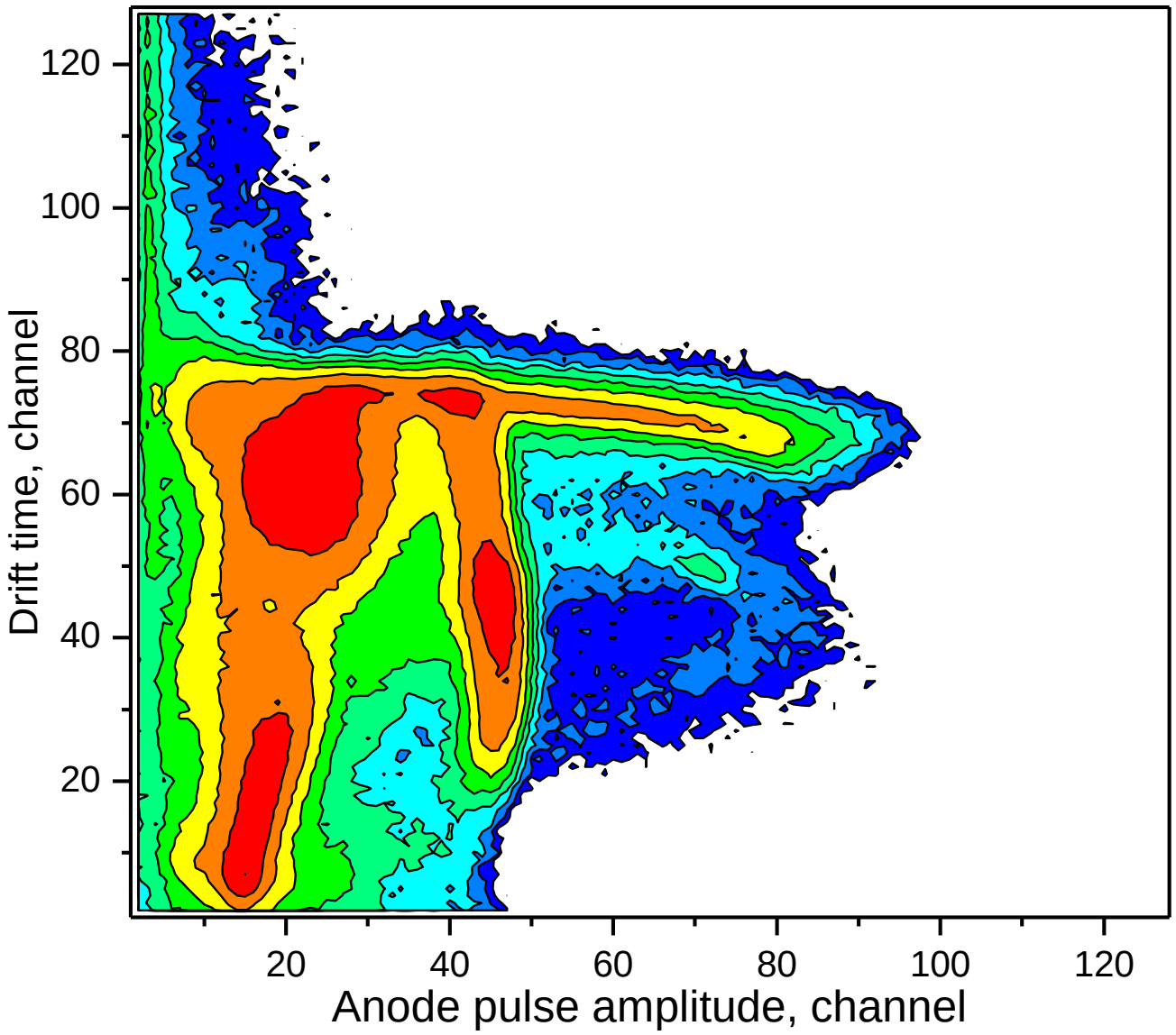



Pulse height spectrum of 238U neutron monitor
- Neutron beam ON
- Neutron beam OFF
238U(n,fission)
238U(α decay)
Counts/channel
Pulse amplitude (channel)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100
110

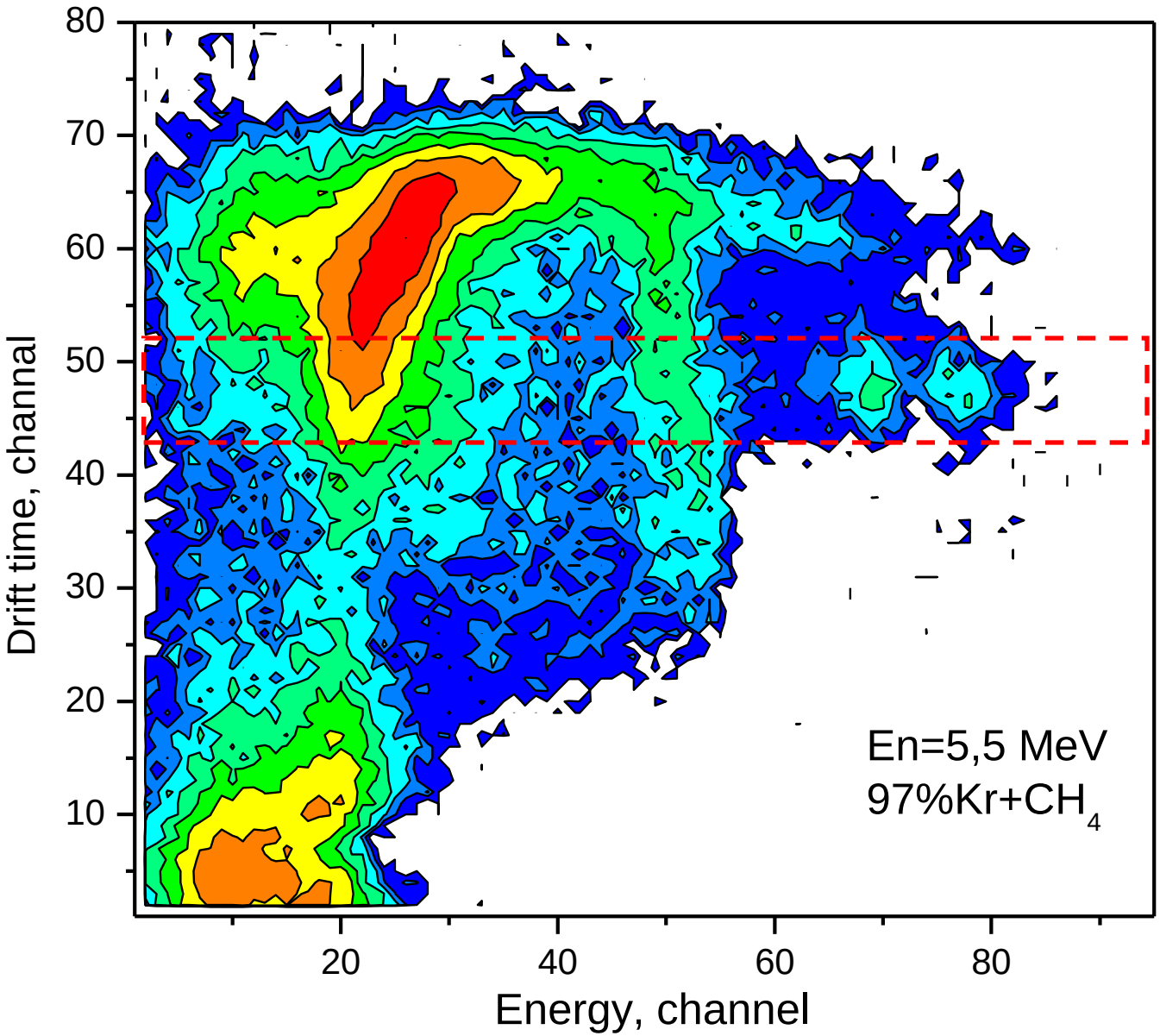
Background suppression



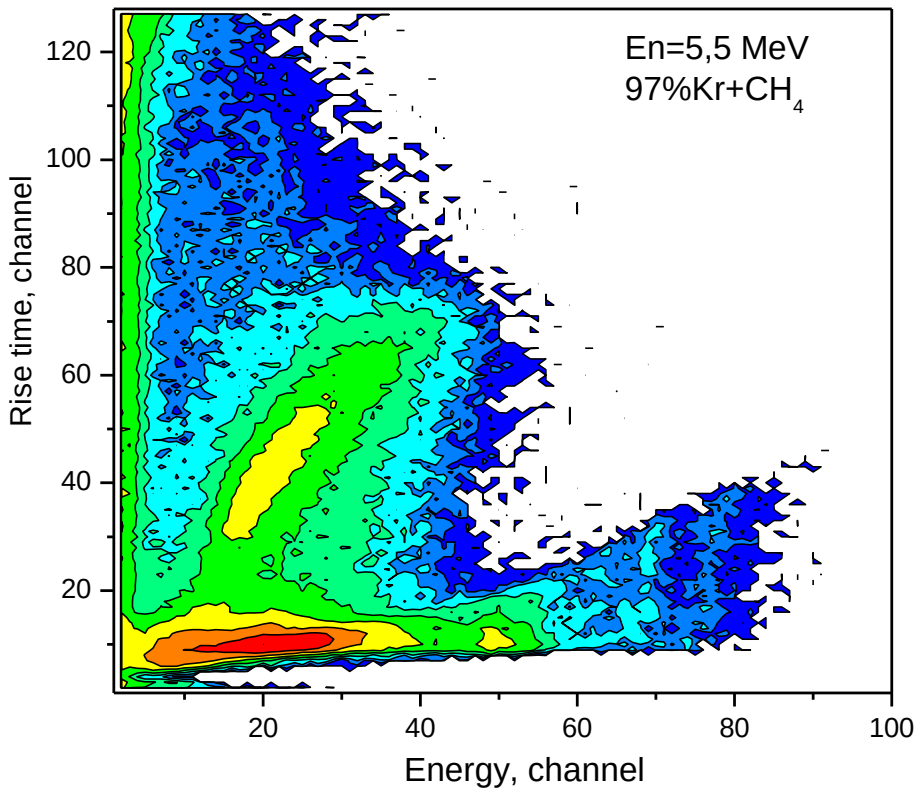
Result for solid target with stainless still cathode

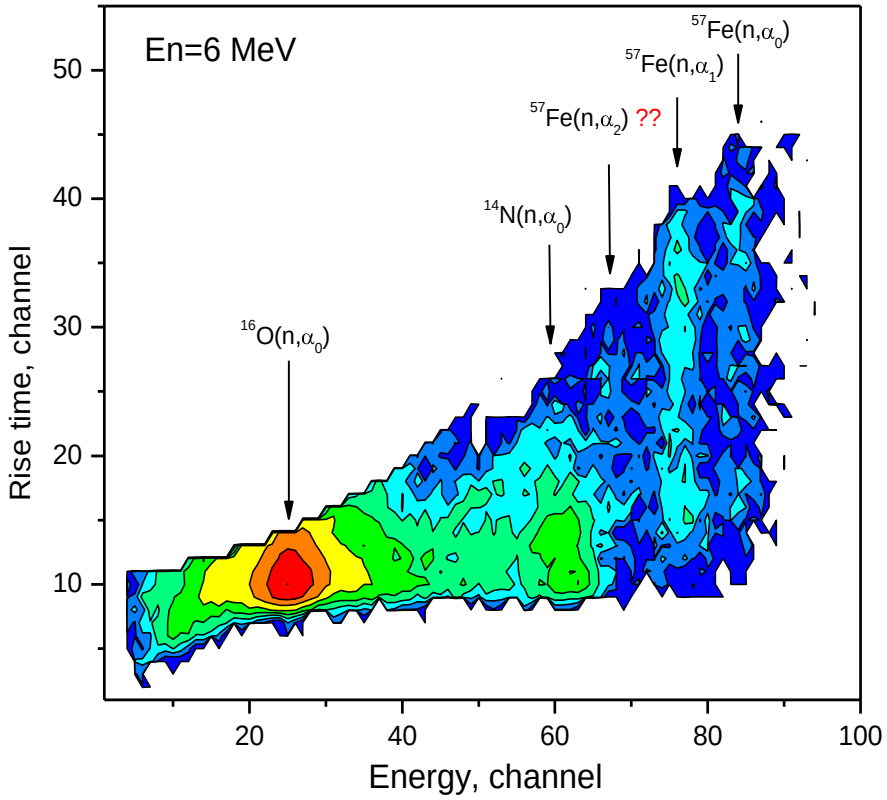


Drift time selection

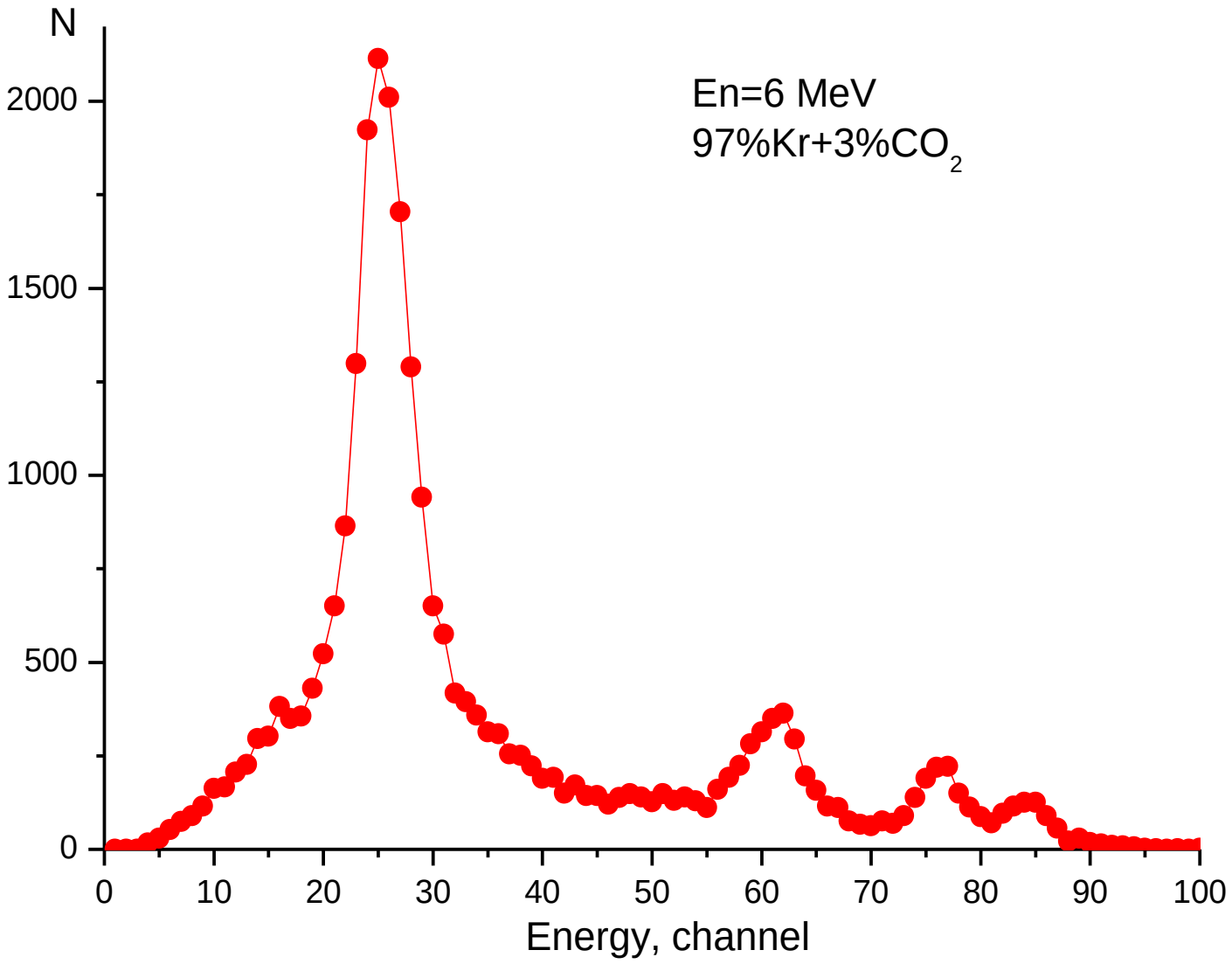


Rise time of anode signals

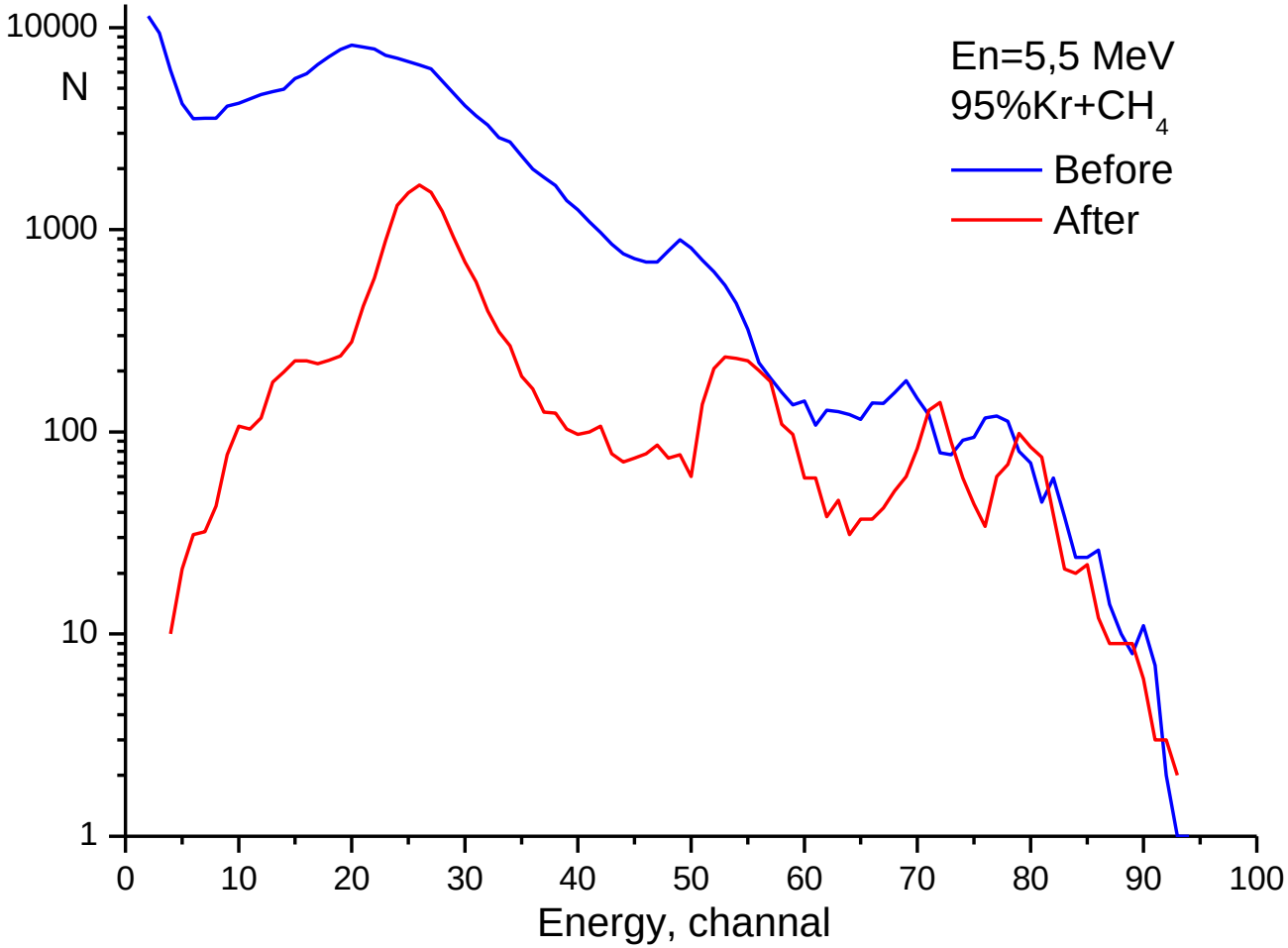




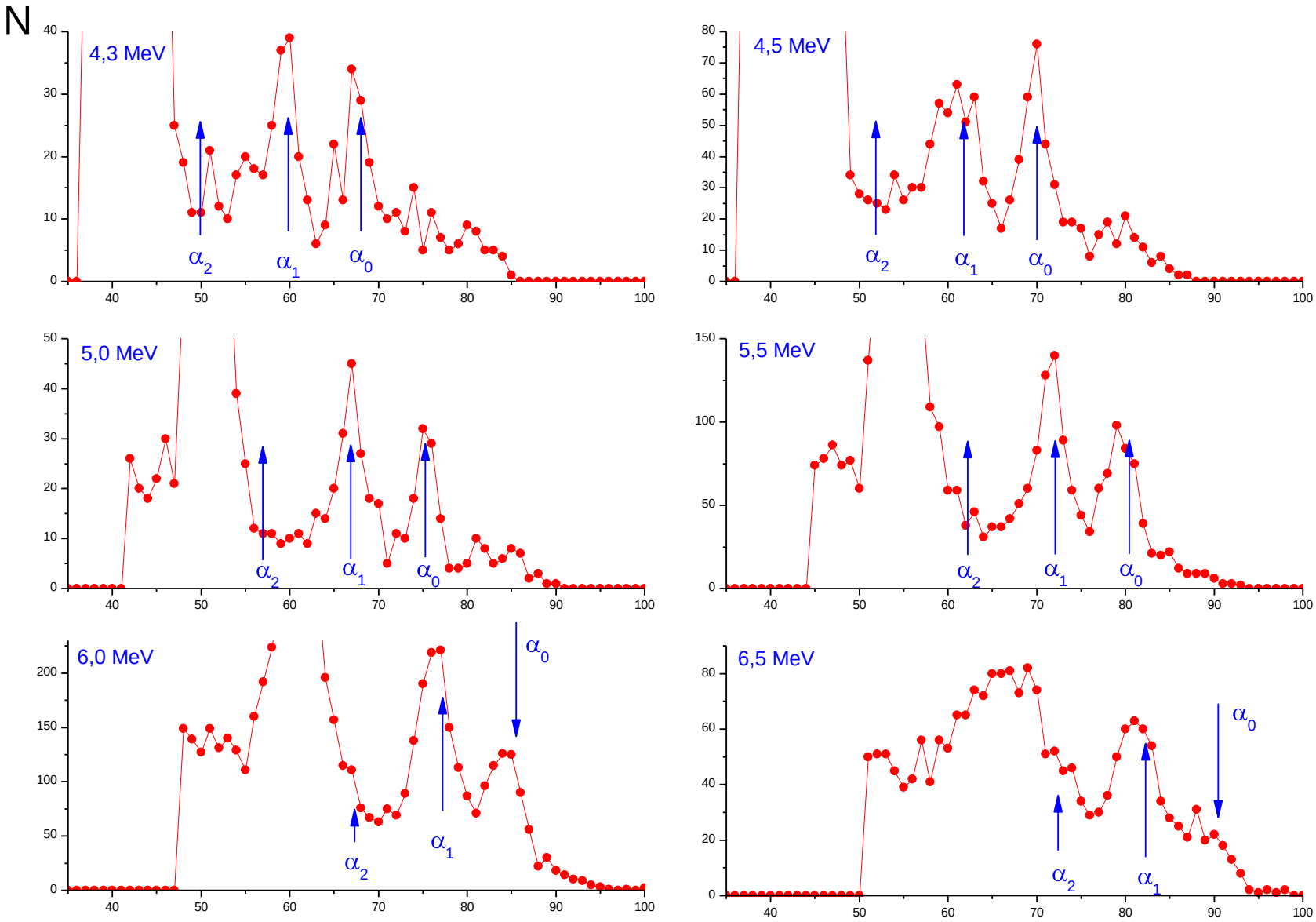
$Kr+CO_2$ gas mixture



Recoil proton rejection



Anode pulse amplitude spectra

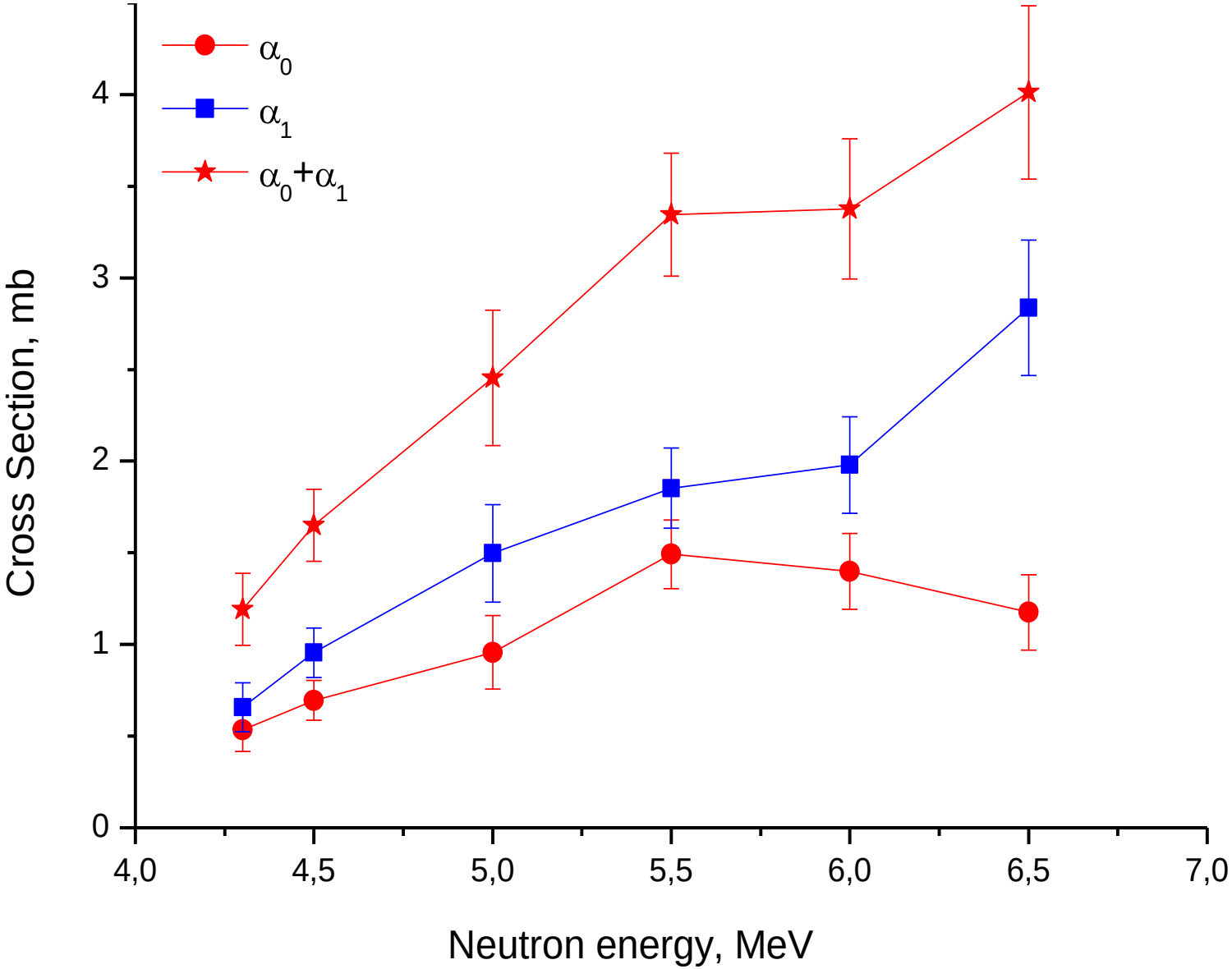


Kr contribution

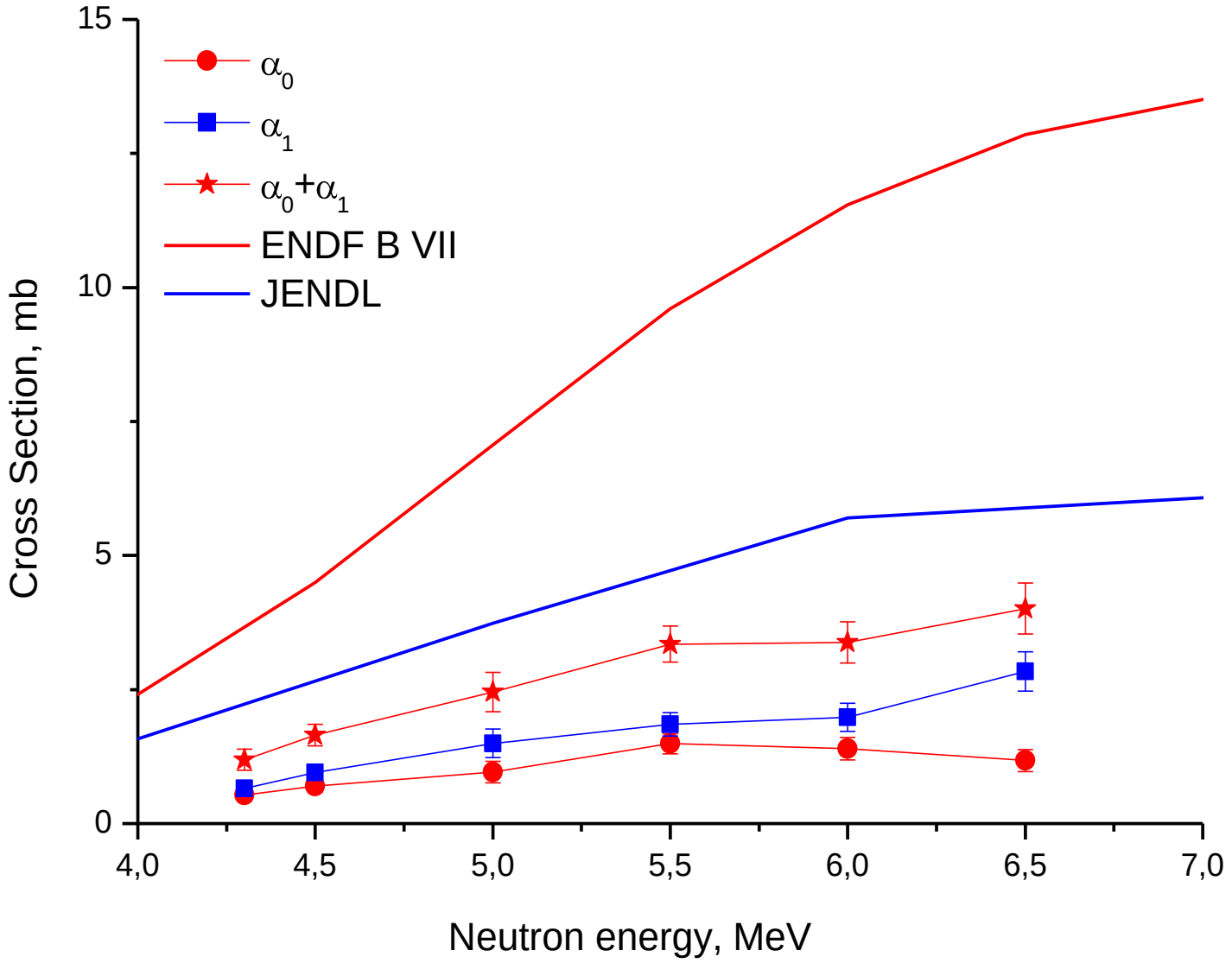
Isotope	Natural abundance, %	(n,α) reaction Q-value, MeV
^{78}Kr	**0,35**	**+3,67**
^{80}Kr	**2,25**	**+2,352**
^{82}Kr	11,6	+0,974
^{83}Kr	**11,5**	**+ 3,426**
^{84}Kr	57,0	-0,390
^{86}Kr	17,3	- 2,273

^{57}Fe	**2,15**	**+2,398**

Preliminary result



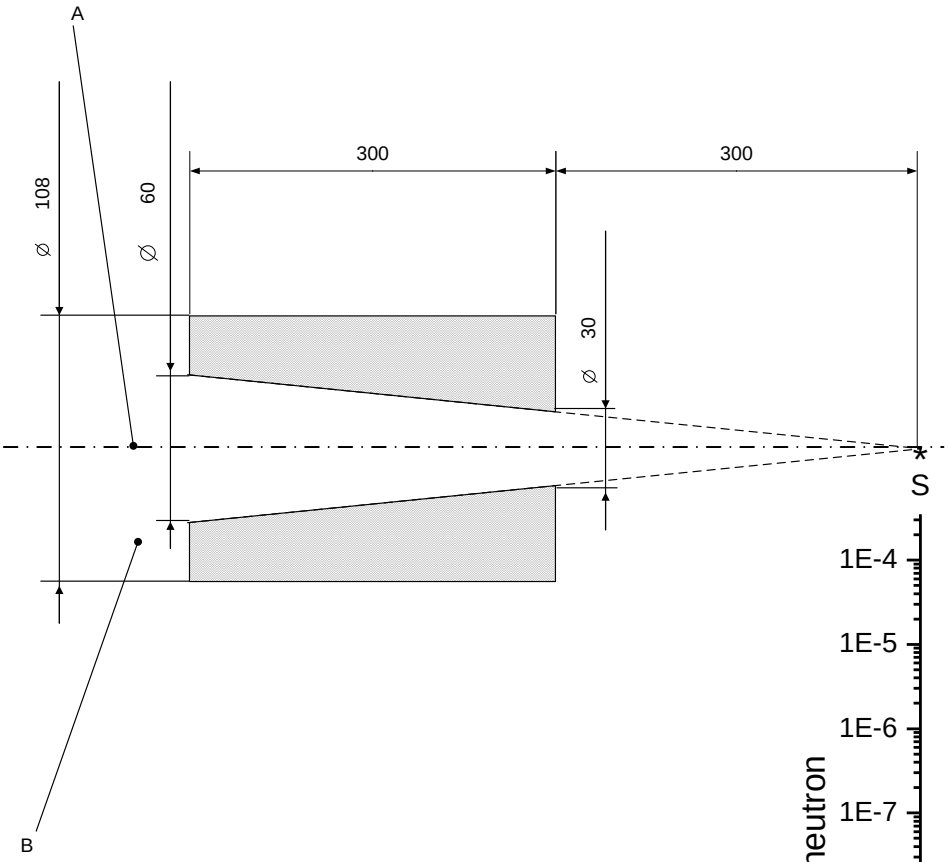
Result for $^{57}Fe(n,\alpha)^{54}Cr$ reaction cross section

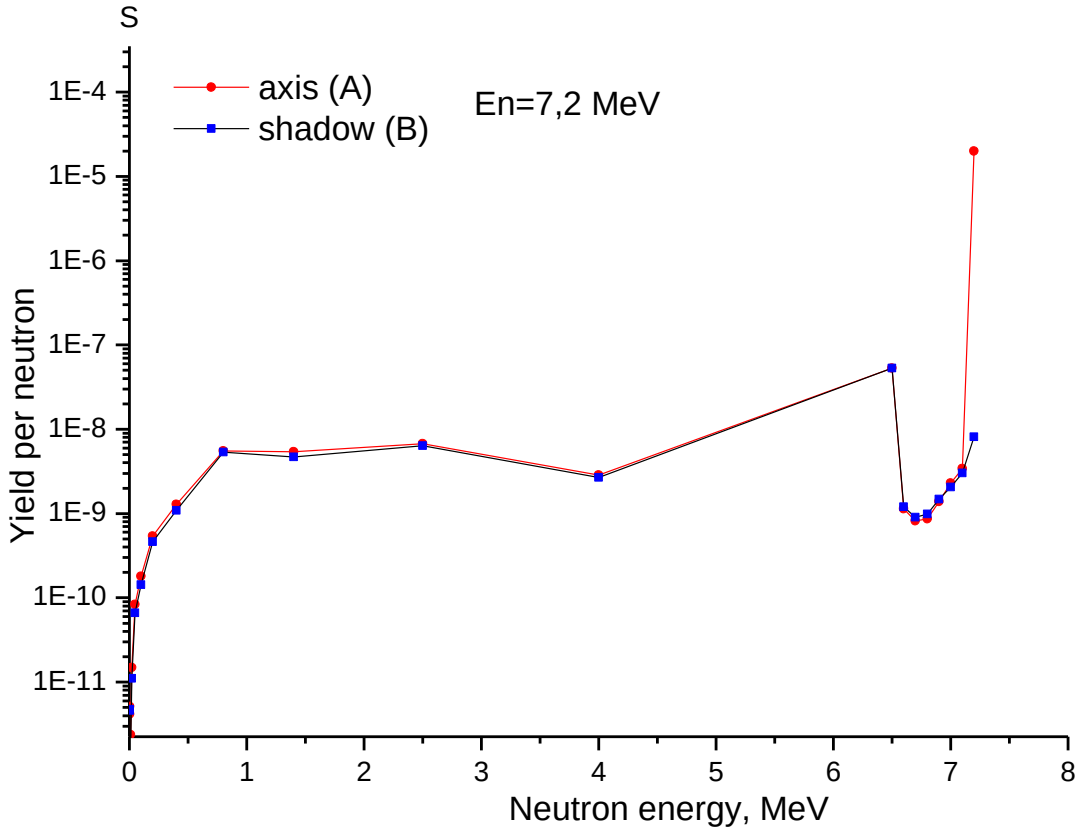


Conclusion

- Spectrometer with a thin self-supported ^{57}Fe target for (n,α) reaction cross-section investigation was developed.
- Digital algorithms for background suppression was found.
- $^{57}Fe(n,\alpha)^{46}Cr$ cross section in neutron energy region from 4,3 to 7 MeV was measured.
- Big discrepancy with JENDL 3 (100%) and with ENDF/B VII (up to 400%) was found.
- ^{54}Cr, ^{56}Fe - next

Thank you for attention !


A
B
S
300
300
108
60
30


axis (A)
shadow (B)
En=7,2 MeV
Yield per neutron
Neutron energy, MeV
1E-4
1E-5
1E-6
1E-7
1E-8
1E-9
1E-10
1E-11
0
1
2
3
4
5
6
7
8