The (n,α) reaction cross section measurement for light isotopes

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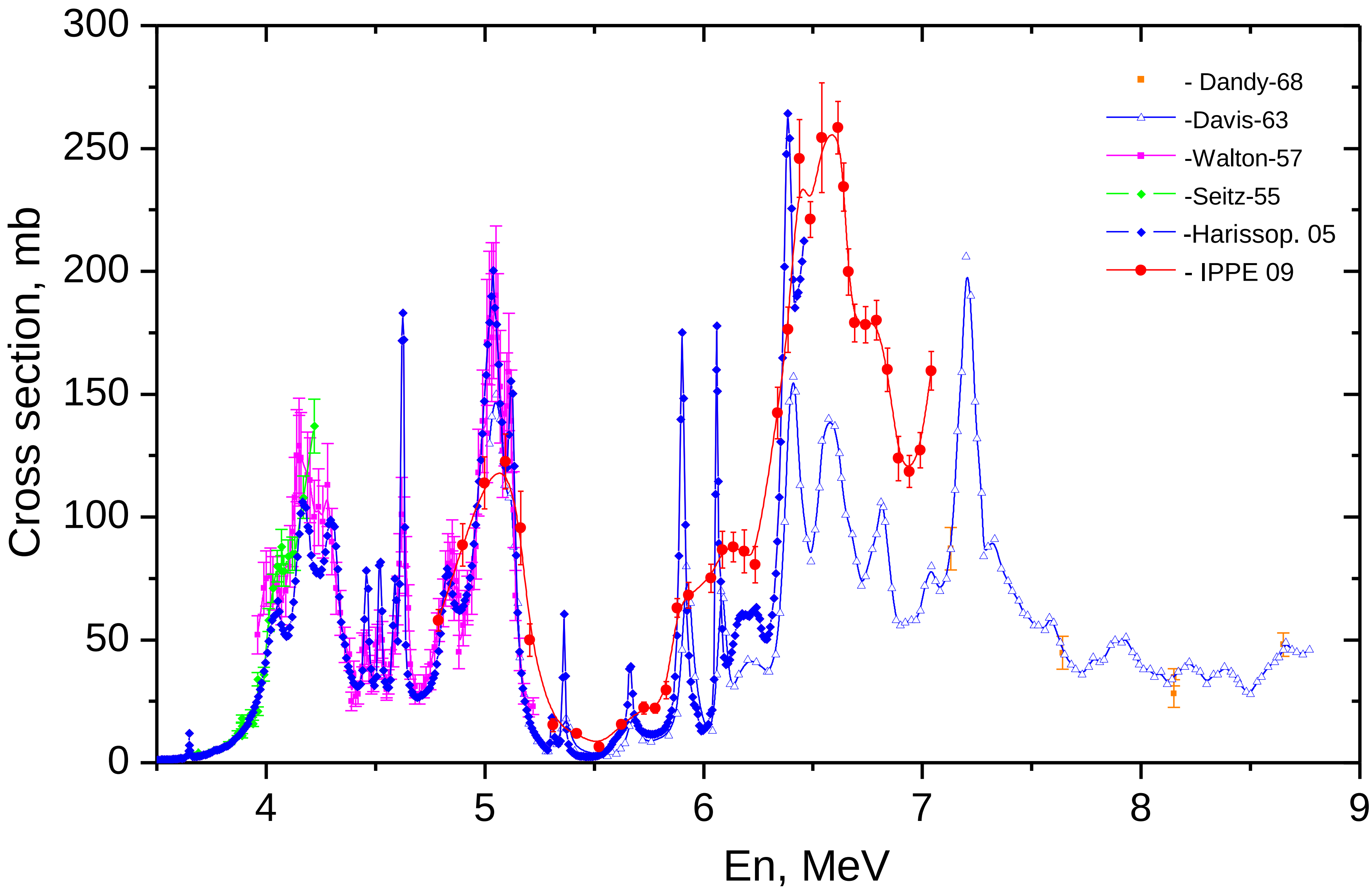
Justification for (n,α) reactions cross section measurement

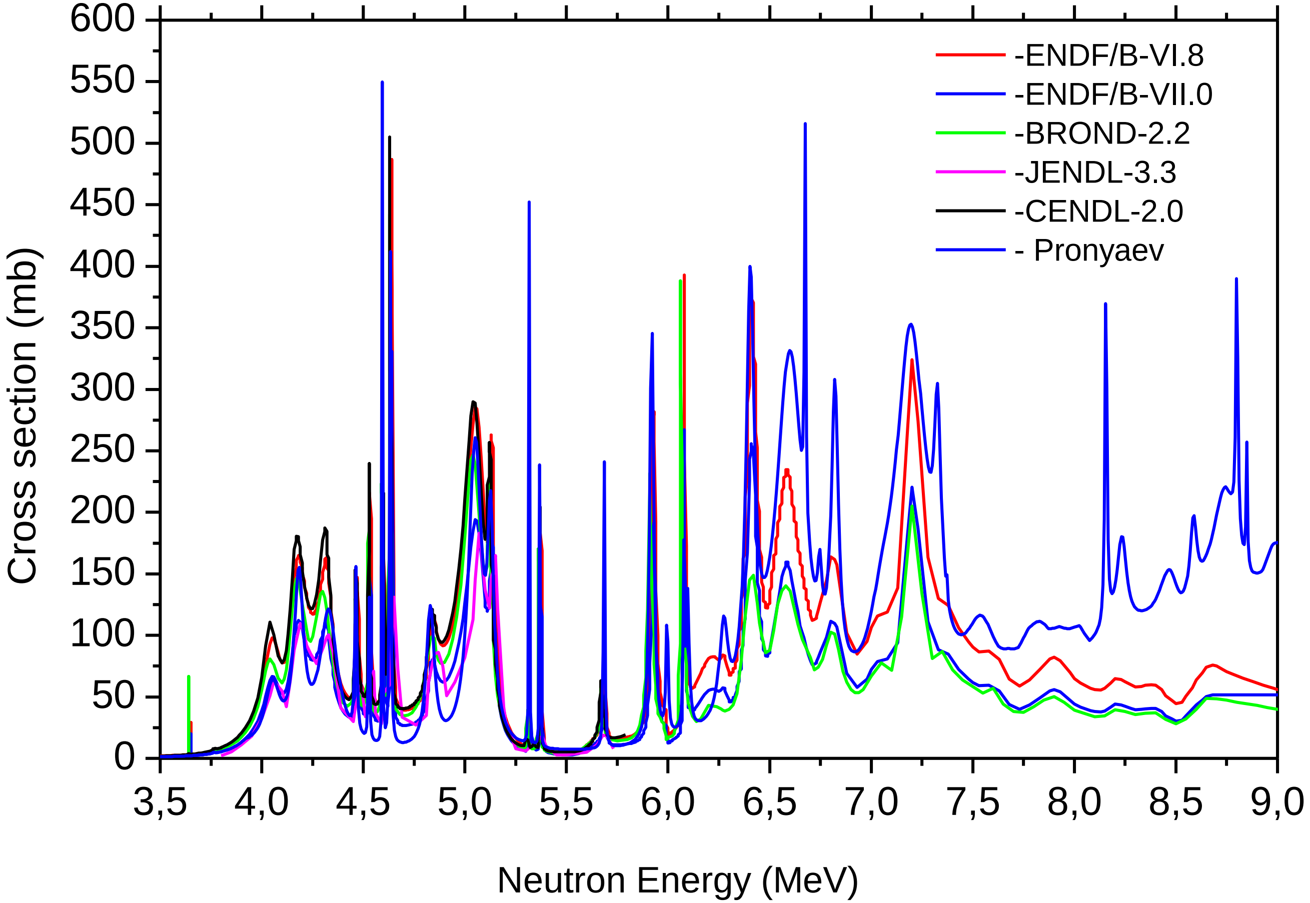
^{10}B, ^{12}C, ^{14}N, ^{16}O, ^{19}F

- **Reactivity predictions of thermal and fast reactors (All);**
- **Calculation of helium production in fuel pins and claddings of reactors (^{12}C, ^{14}N, ^{16}O, ^{19}F);**
- **Standard (^{10}B)**
- **Calibration of a strength of neutron sources (^{16}O);**
- **Astrophysics;**
- **Dosimetry.**

Status of $^{16}O(n,\alpha)$ reaction experimental data



Evaluations for $^{16}O(n,\alpha)$ reaction

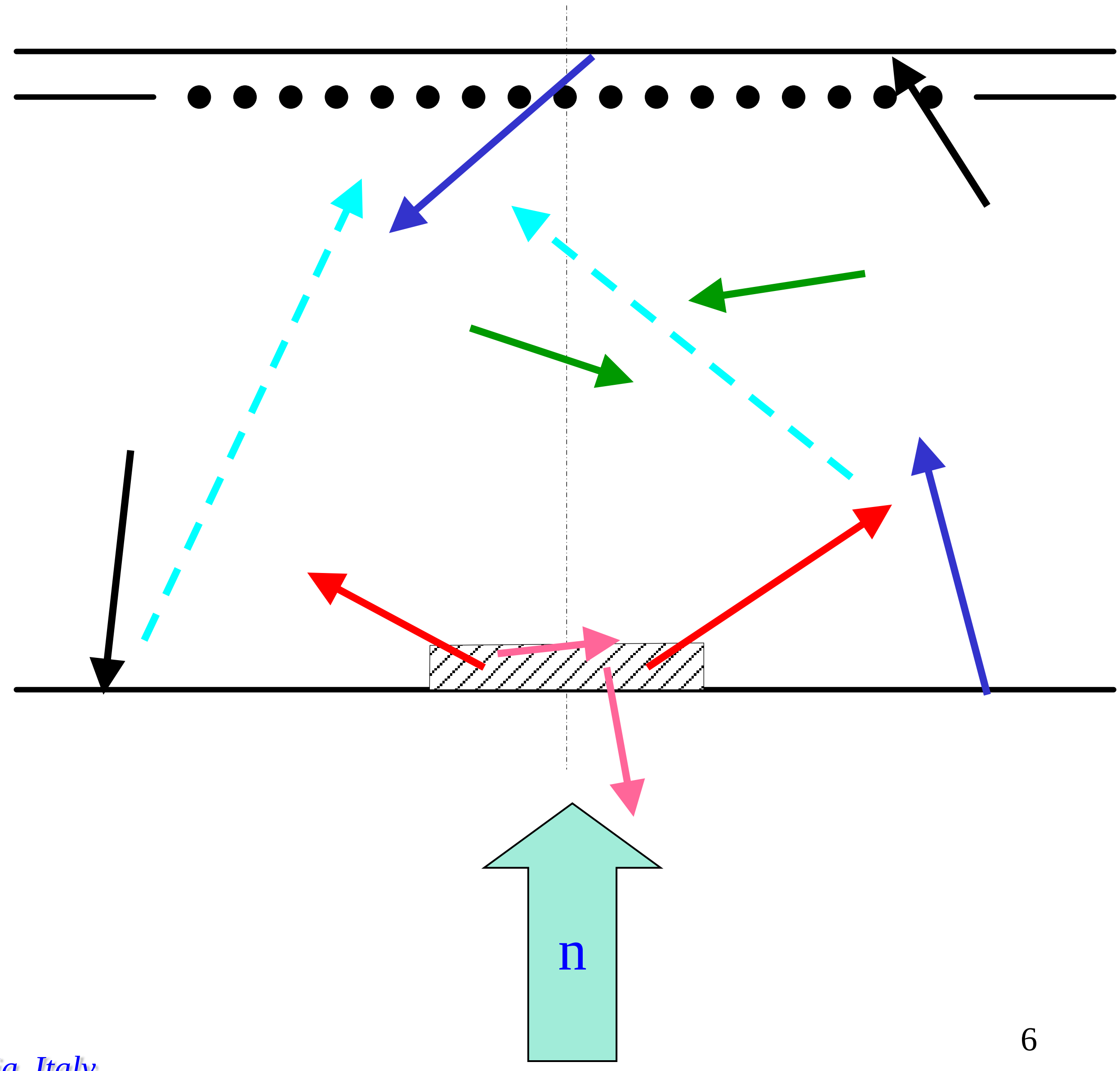


Problems:

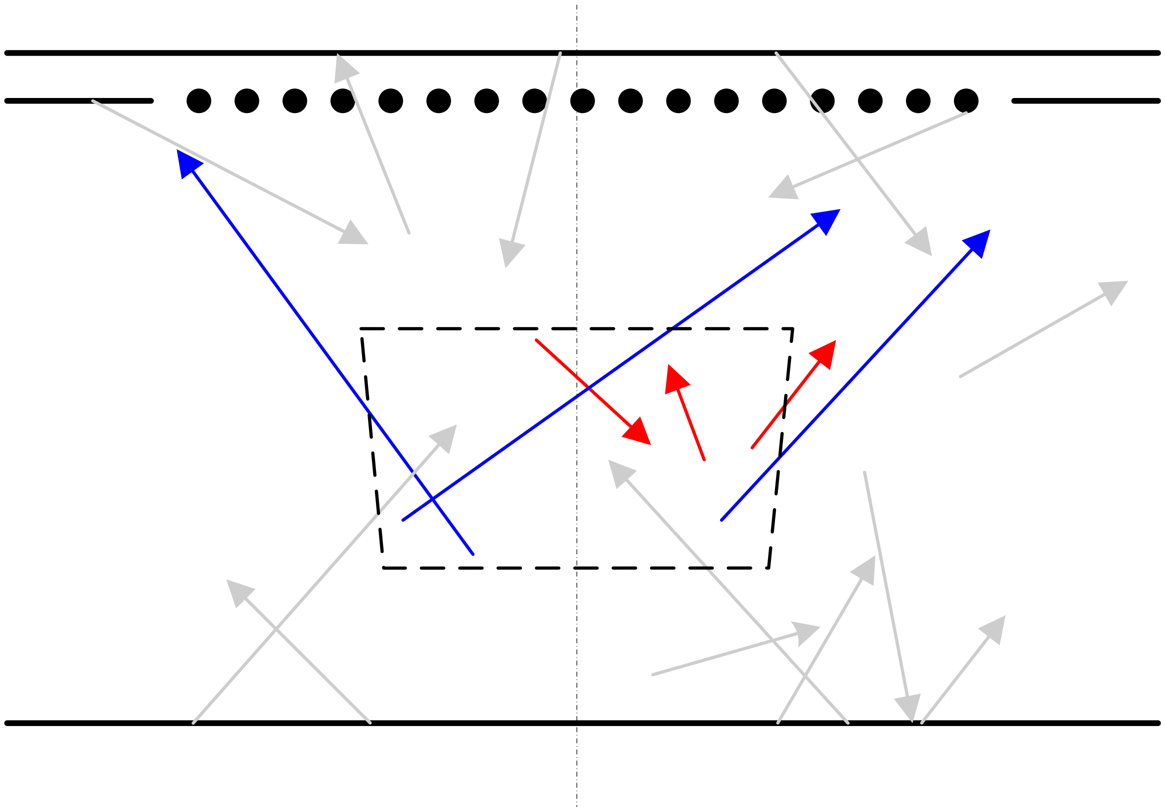
- Detector
- Samples
- Neutron source

Detector. Classical spectrometer

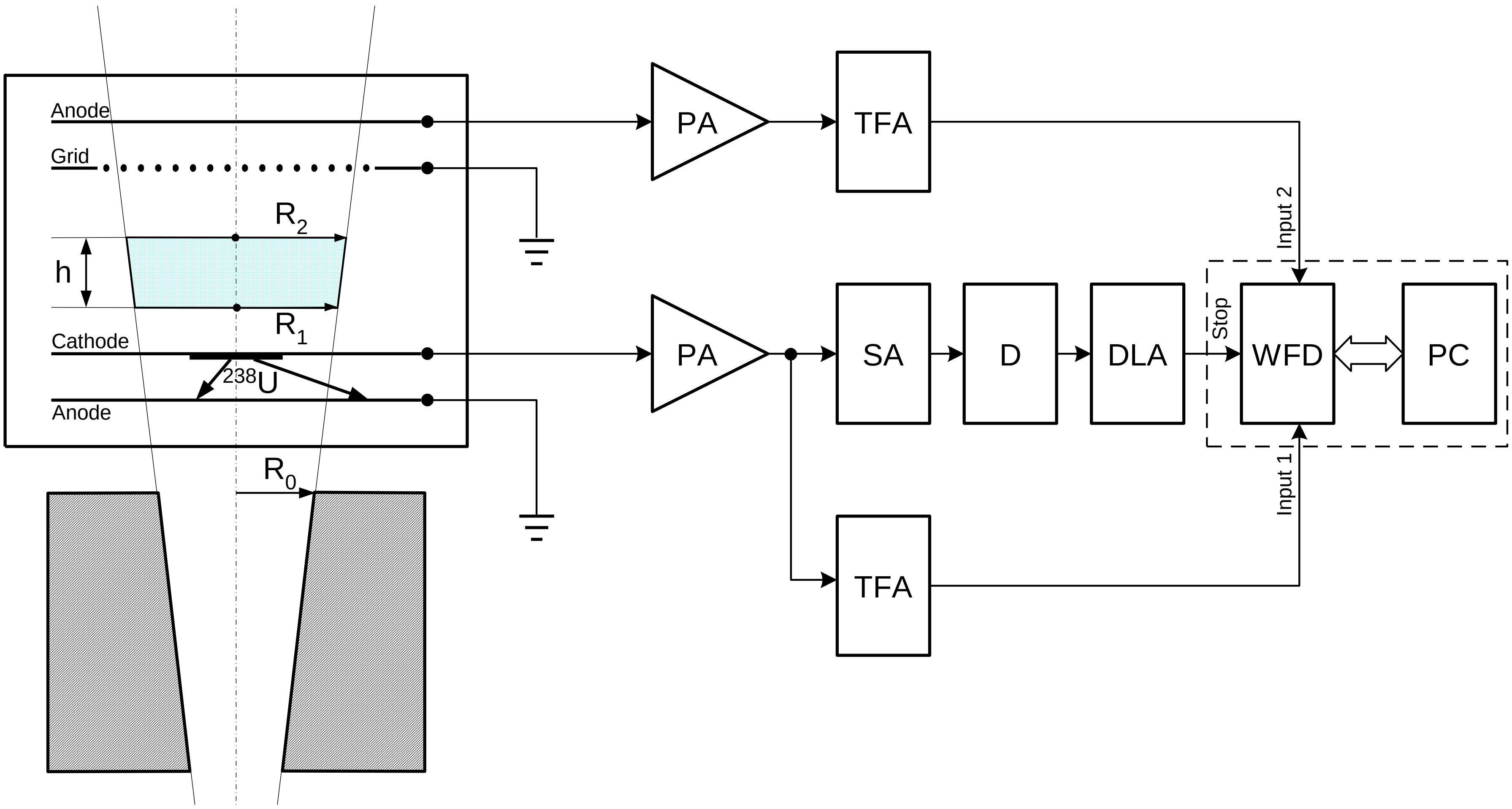
1. Target
2. Full absorption
3. Electrodes
4. Gas α-particles
5. Protons
6. Wall effect



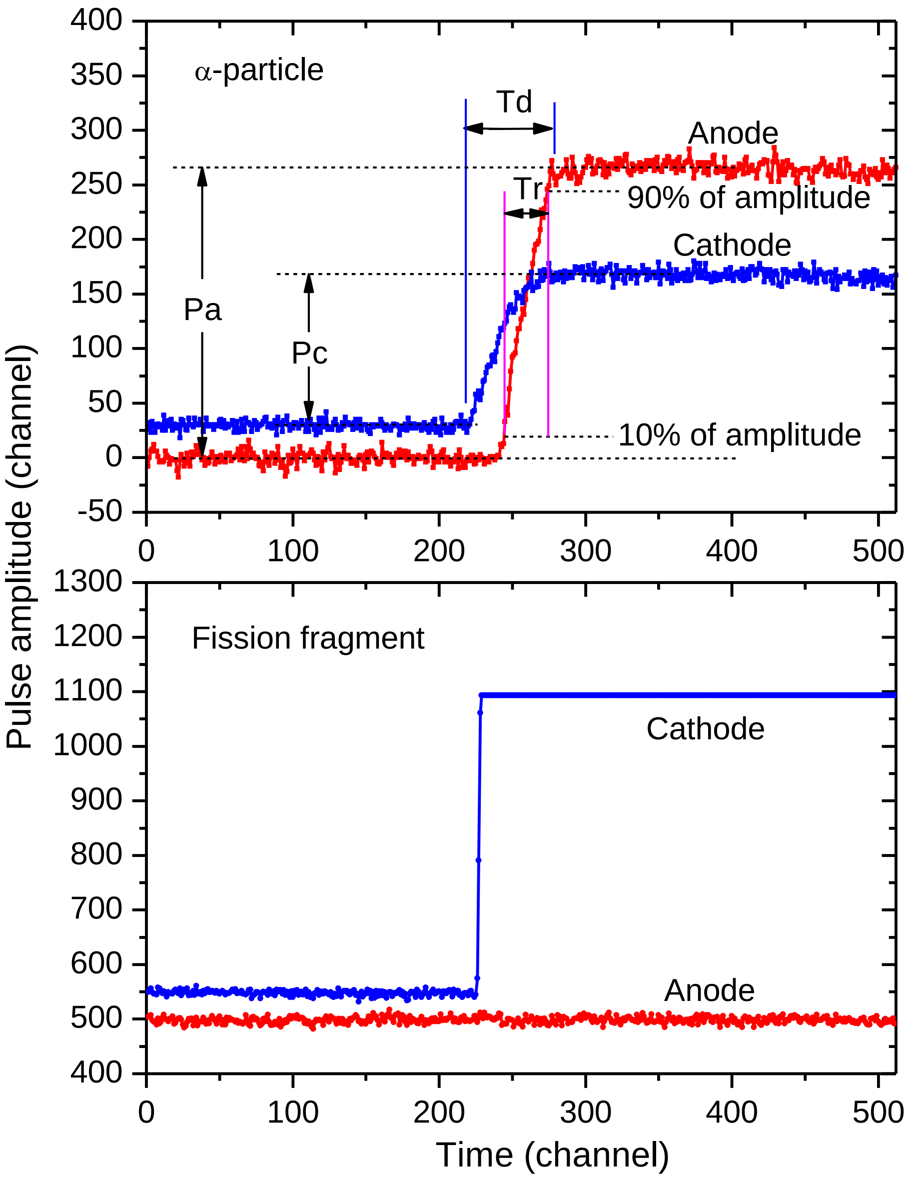
Gaseous target



Experimental set up



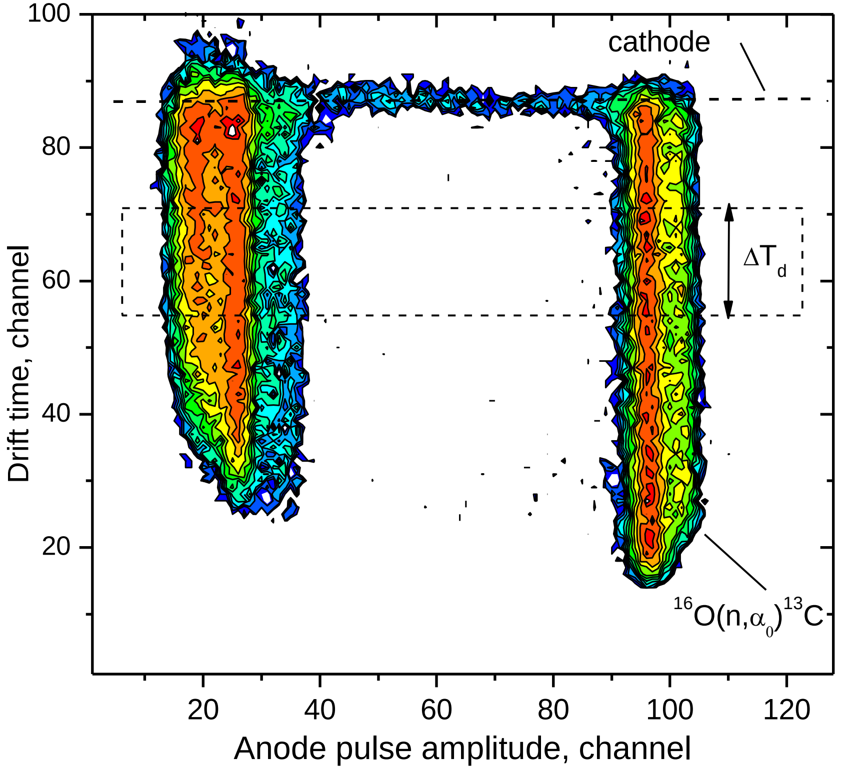
Signals example

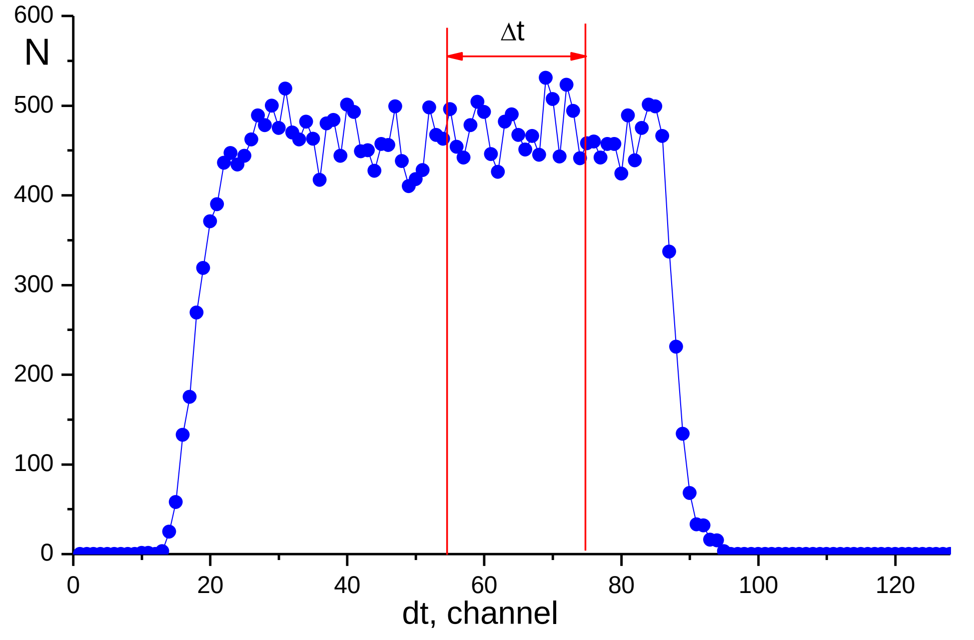


DSP allow you to analyse:

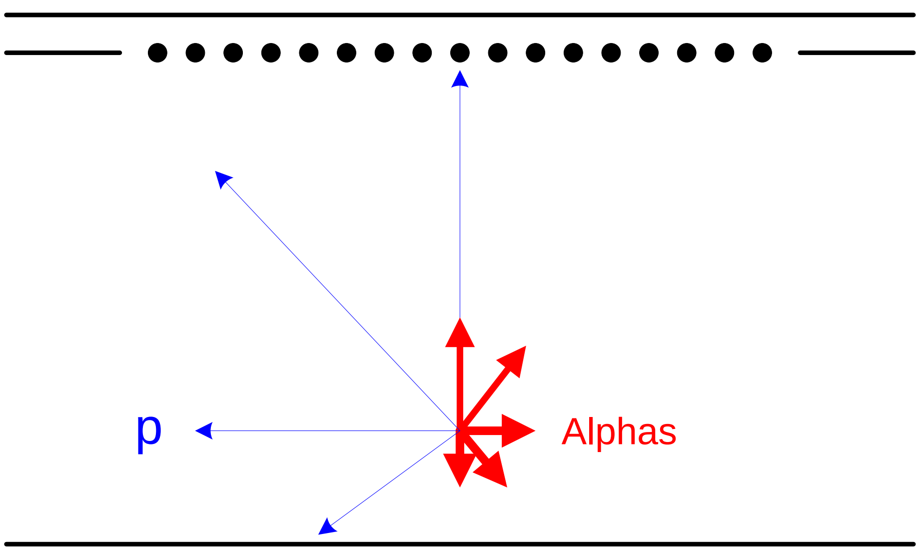
1) Amplitude of anode pulse (P_A);
2) Amplitude of cathode pulse (P_C);
3) Time when cathode signal appears (T_{SC});
4) Time when anode signal appears (T_{SA});
5) Time when anode signal reaches saturation (T_{EA});
6) Time of charge motion in ionizing chamber $T_d=(T_{EA}-T_{SC})$;
7) Time of anode signal rise $T_r= (T_{EA}- T_{SA})$
8) Birth place $X=(D-T_d*v_e)$

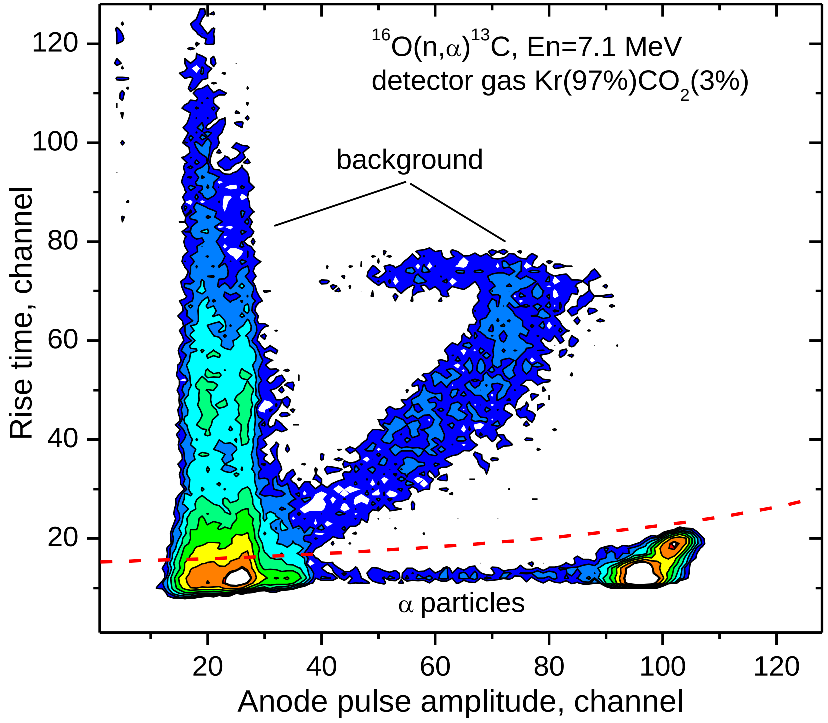
Track vertical position determination



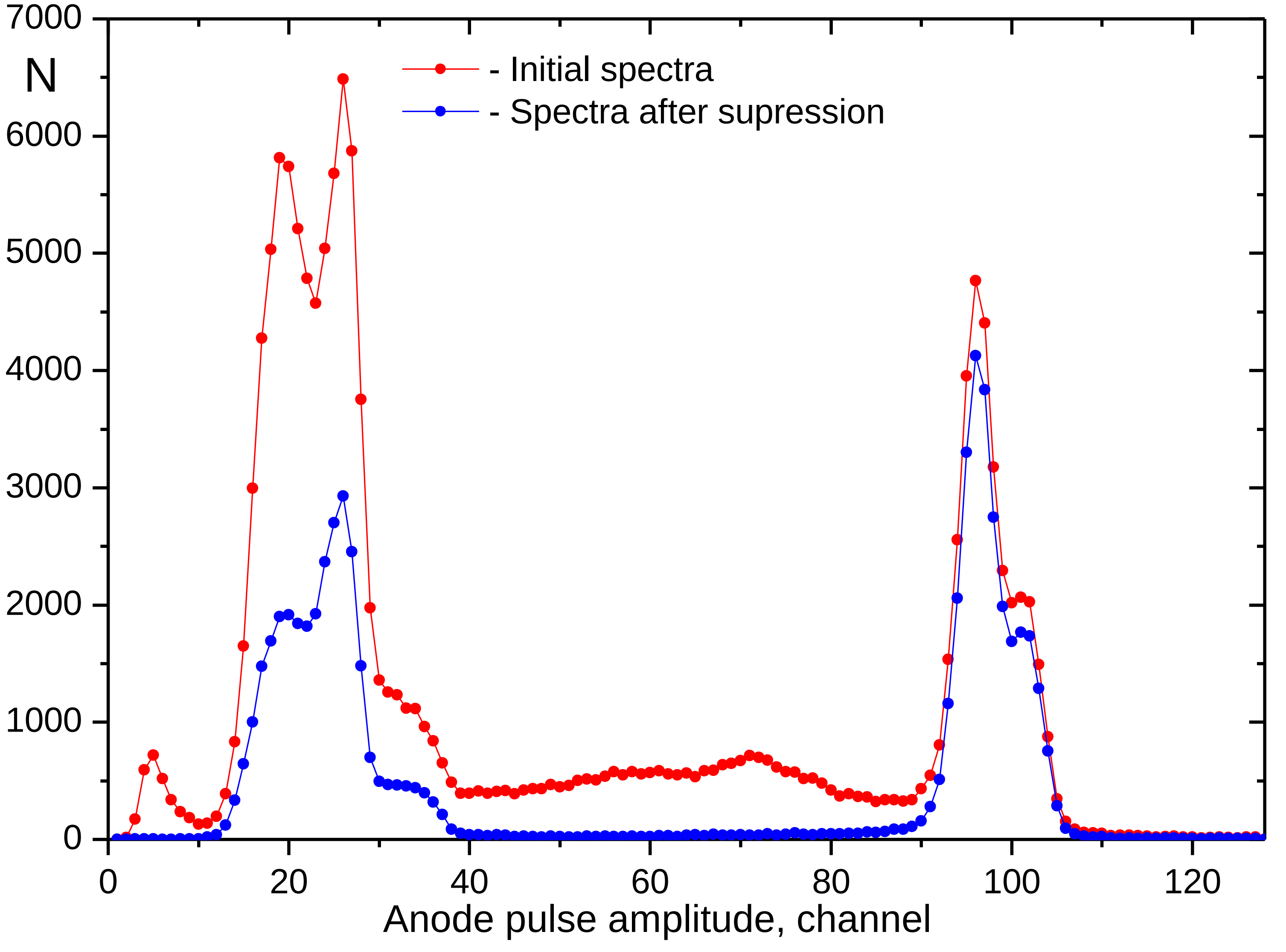


Type of particle determination

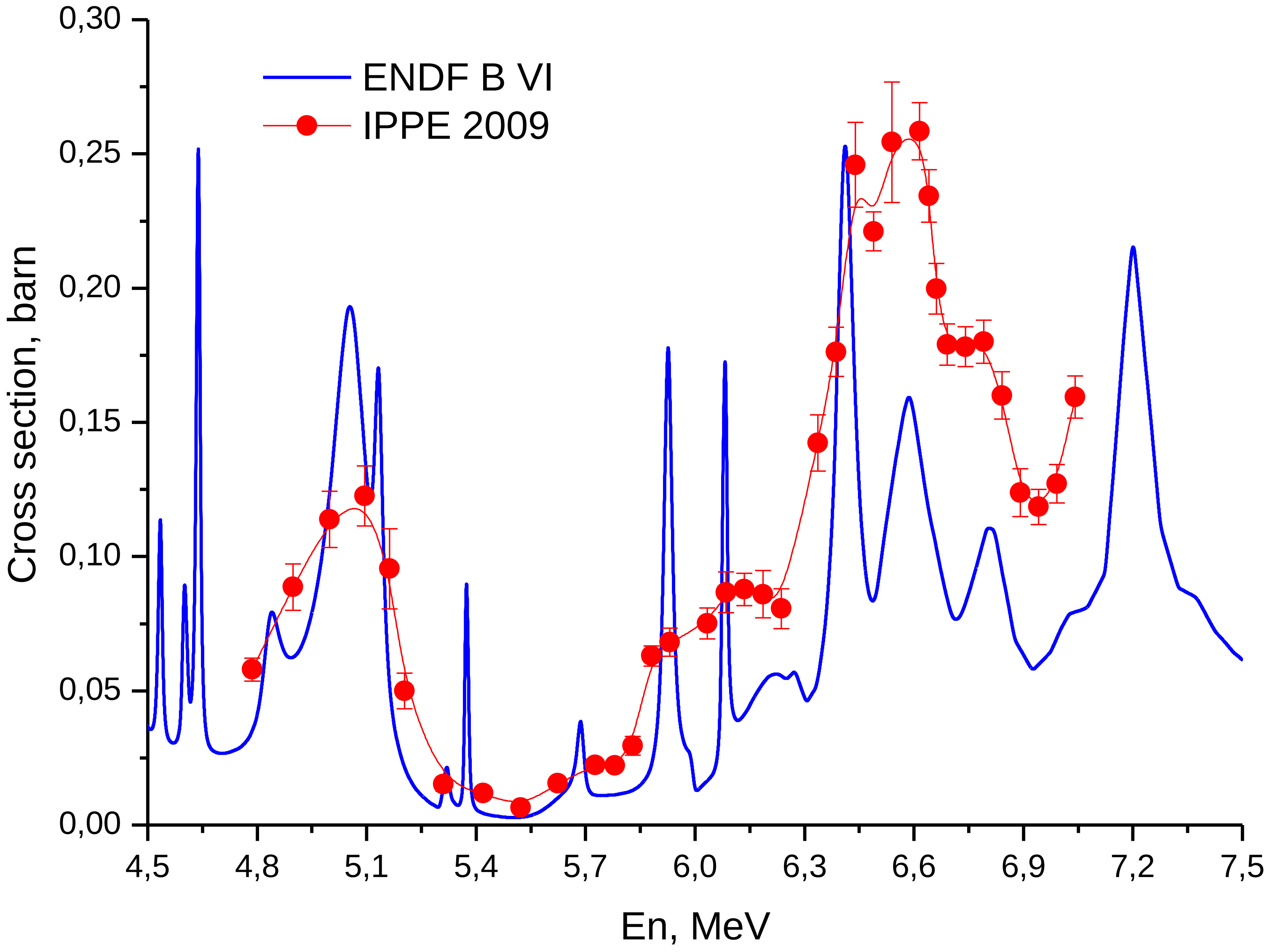




α-particles spectra

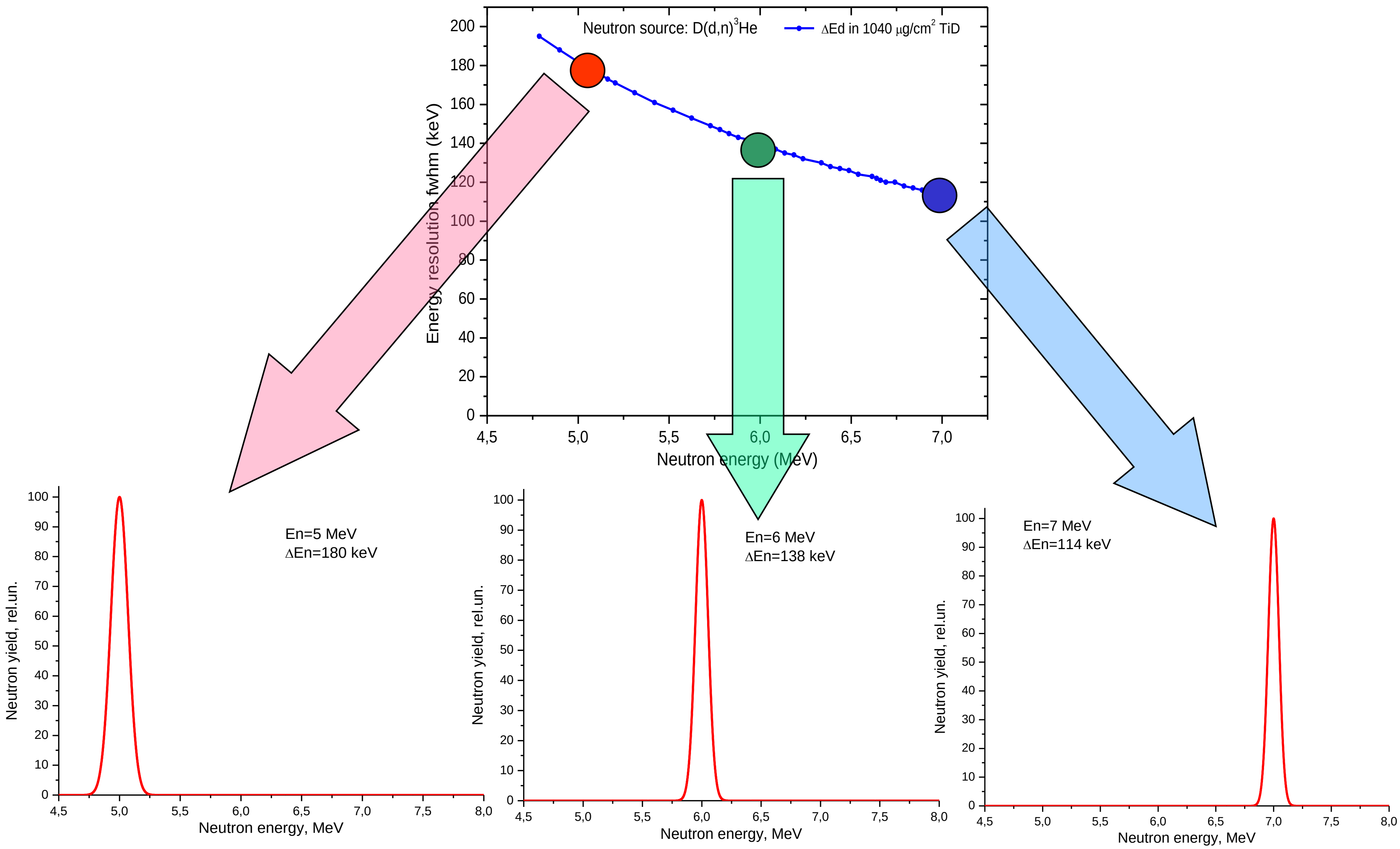


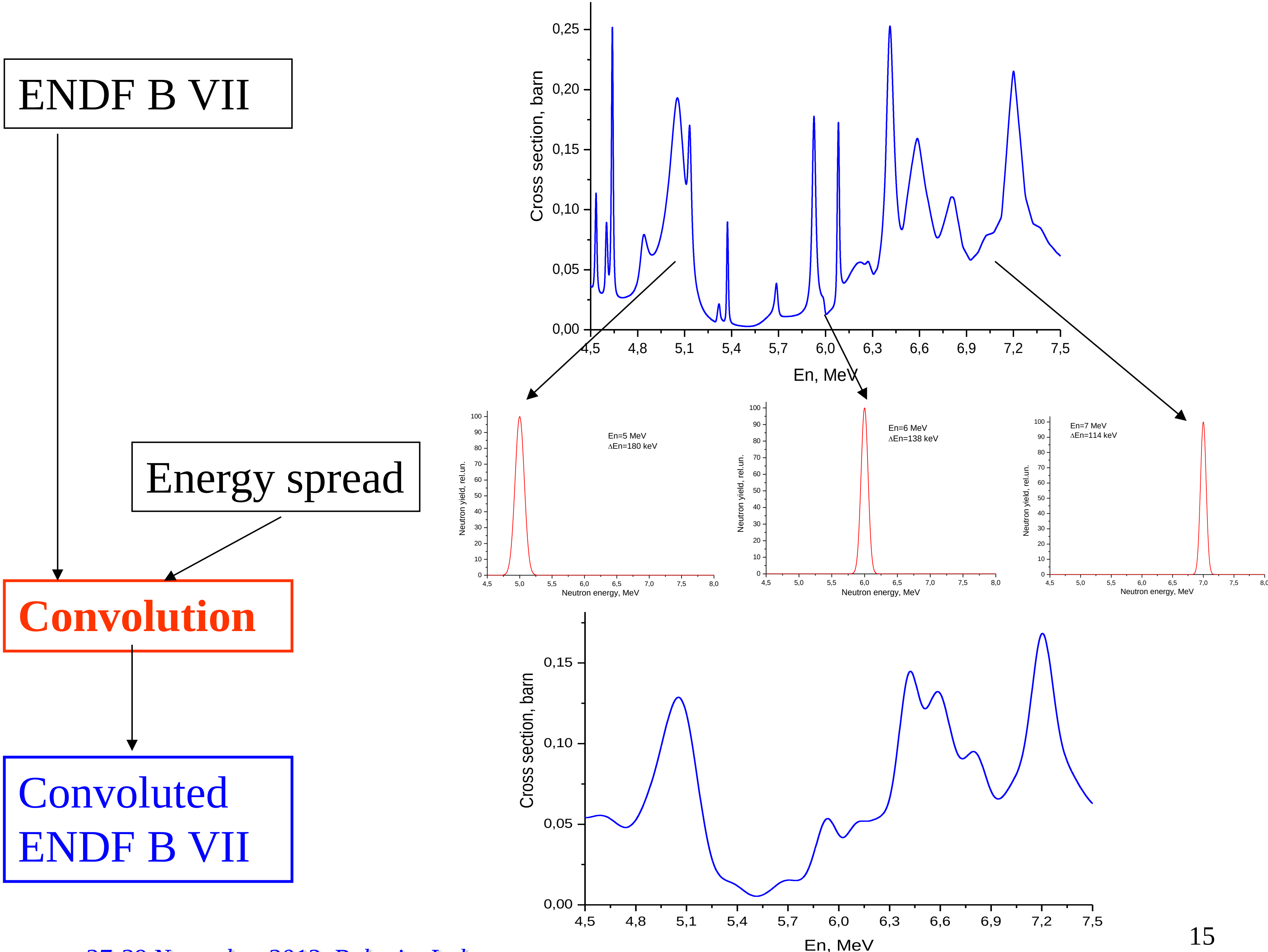
IPPE result



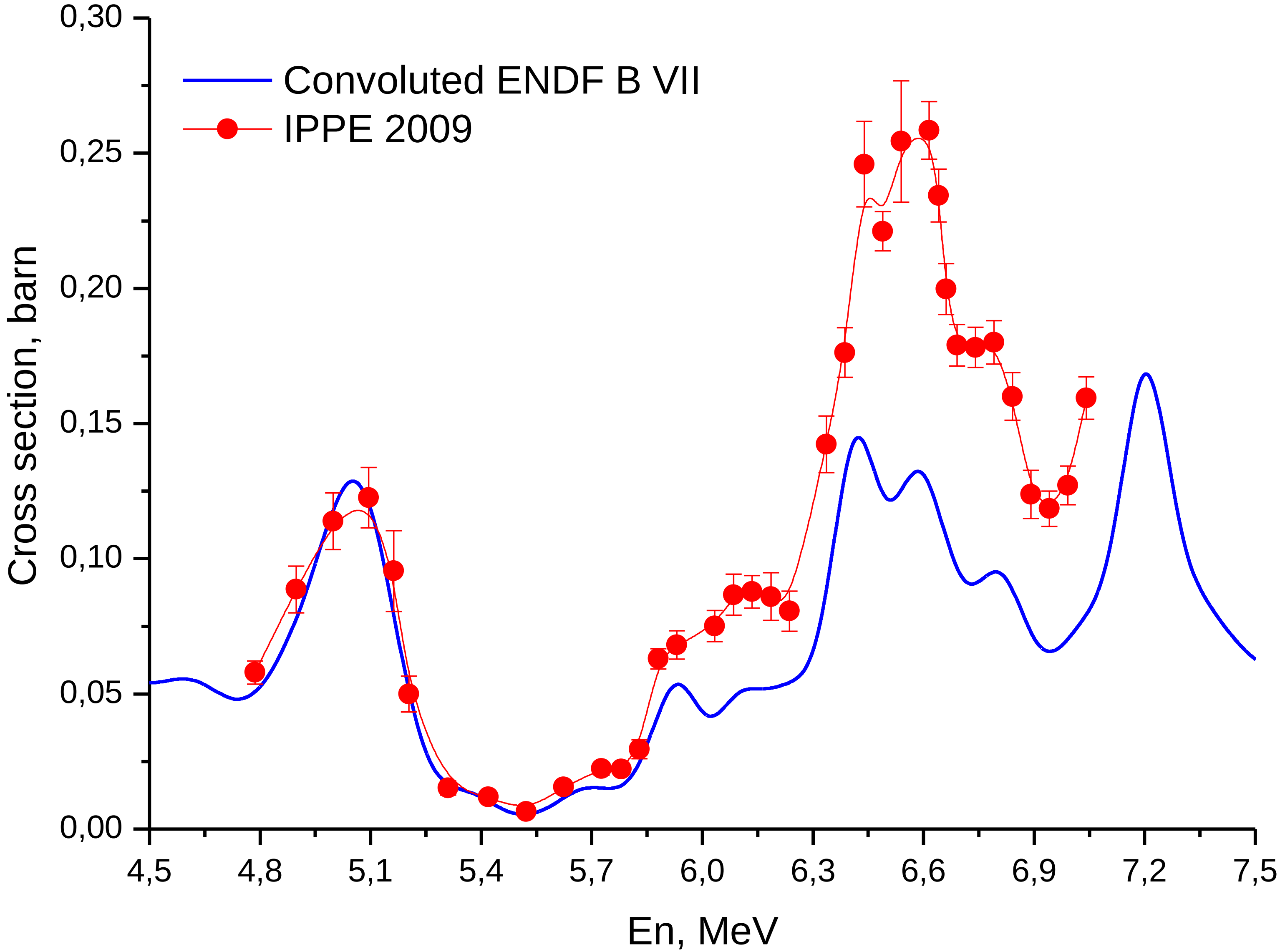
ENDF B VI
IPPE 2009
Cross section, barn
0,30
0,25
0,20
0,15
0,10
0,05
0,00
4,5
4,8
5,1
5,4
5,7
6,0
6,3
6,6
6,9
7,2
7,5
En, MeV

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




ENDF B VII
Energy spread
Convolution
Convoluted ENDF B VII
Cross section, barn
En, MeV
En=5 MeV
ΔEn=180 keV
En=6 MeV
ΔEn=138 keV
En=7 MeV
ΔEn=114 keV
Neutron yield, rel.un.
Neutron energy, MeV
Cross section, barn
En, MeV

Convoluted ENDF vs IPPE experiment

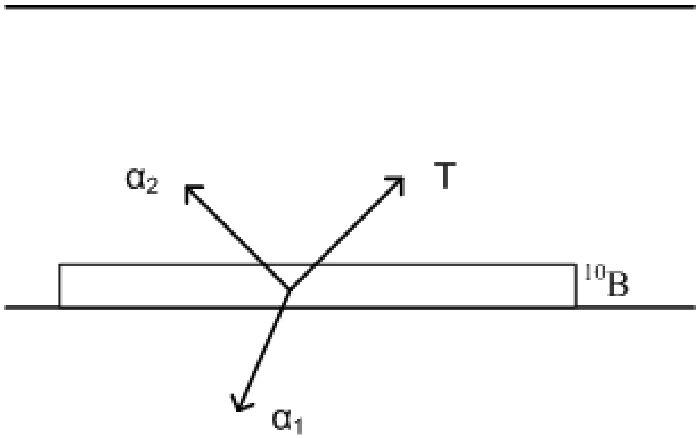


Break up reactions and particle liking effect

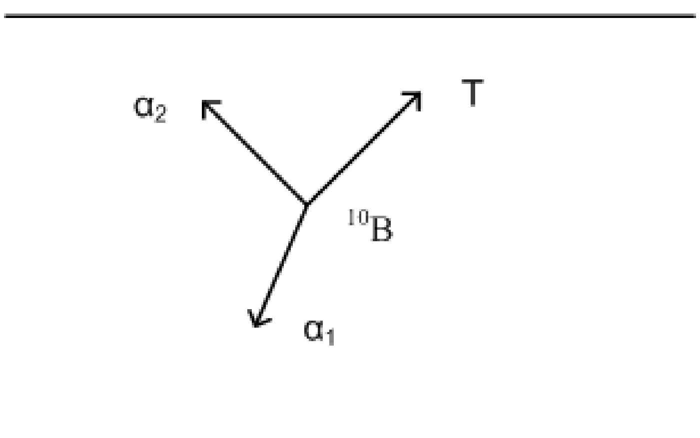
Example:

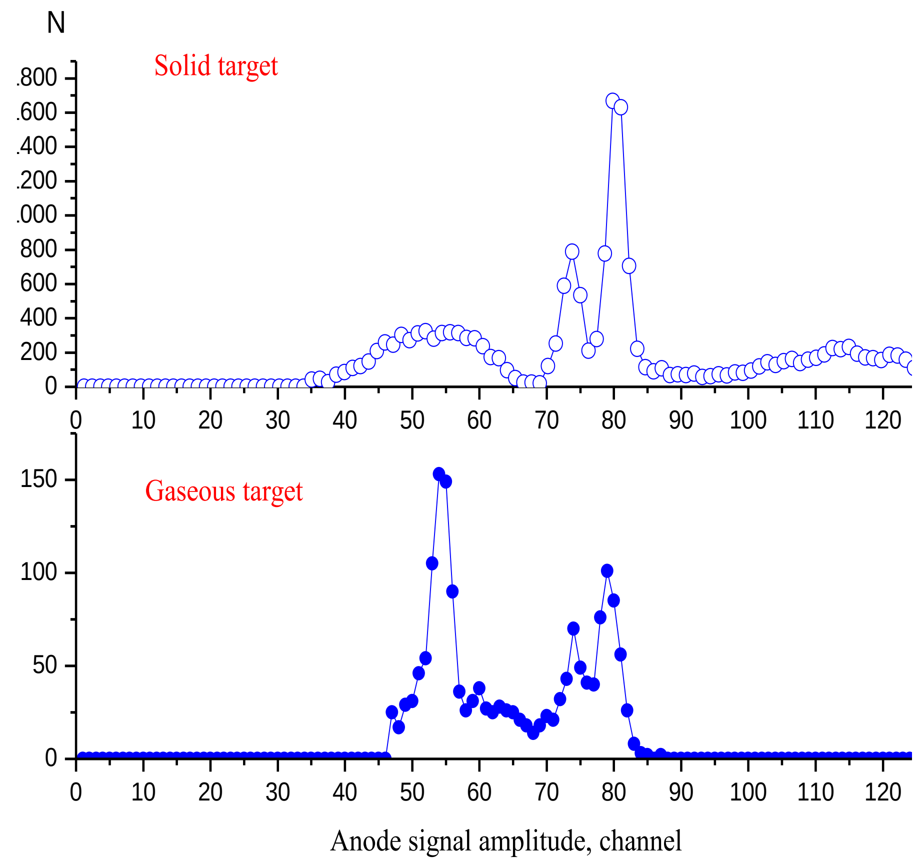
$^{10}B(n,2\alpha)t$

Solid target

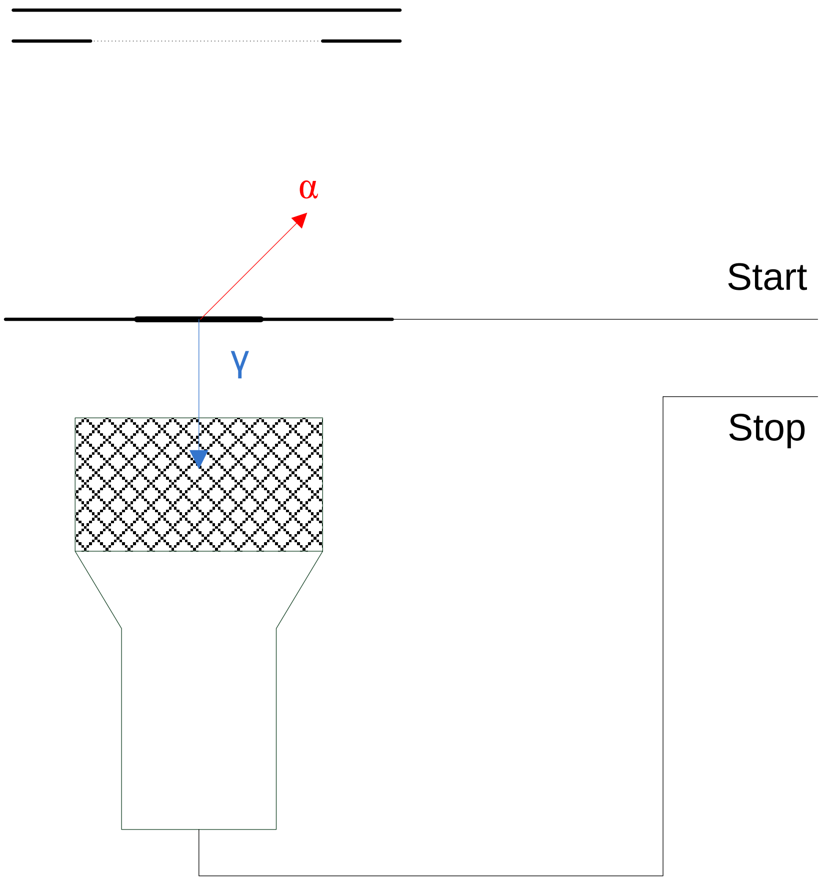


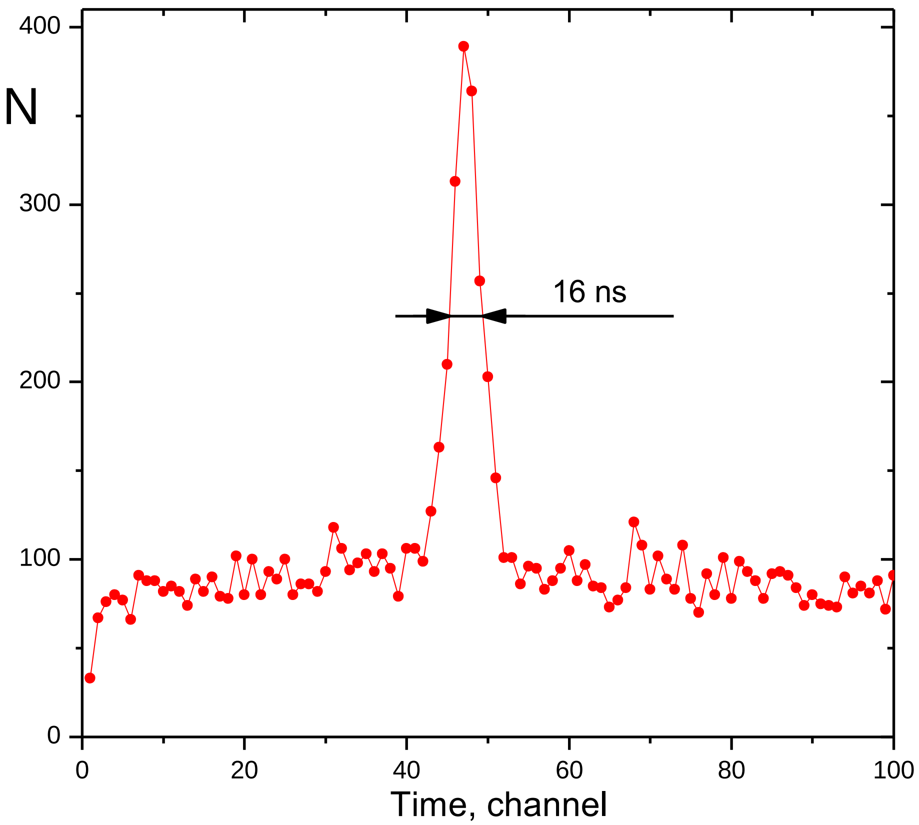
Gaseous target



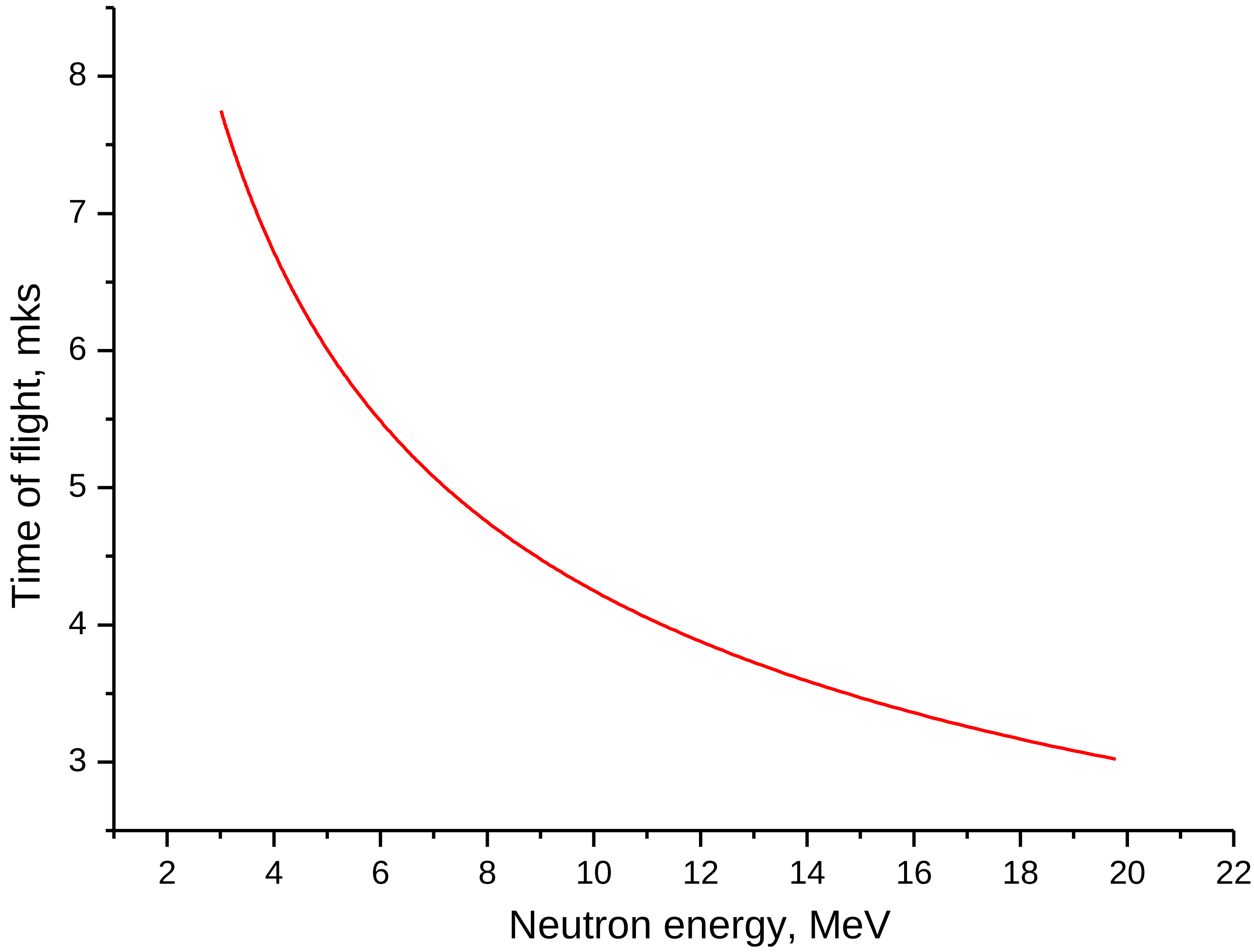


Time of flight spectrum for ^{237}Np target (α-γ coincidence).

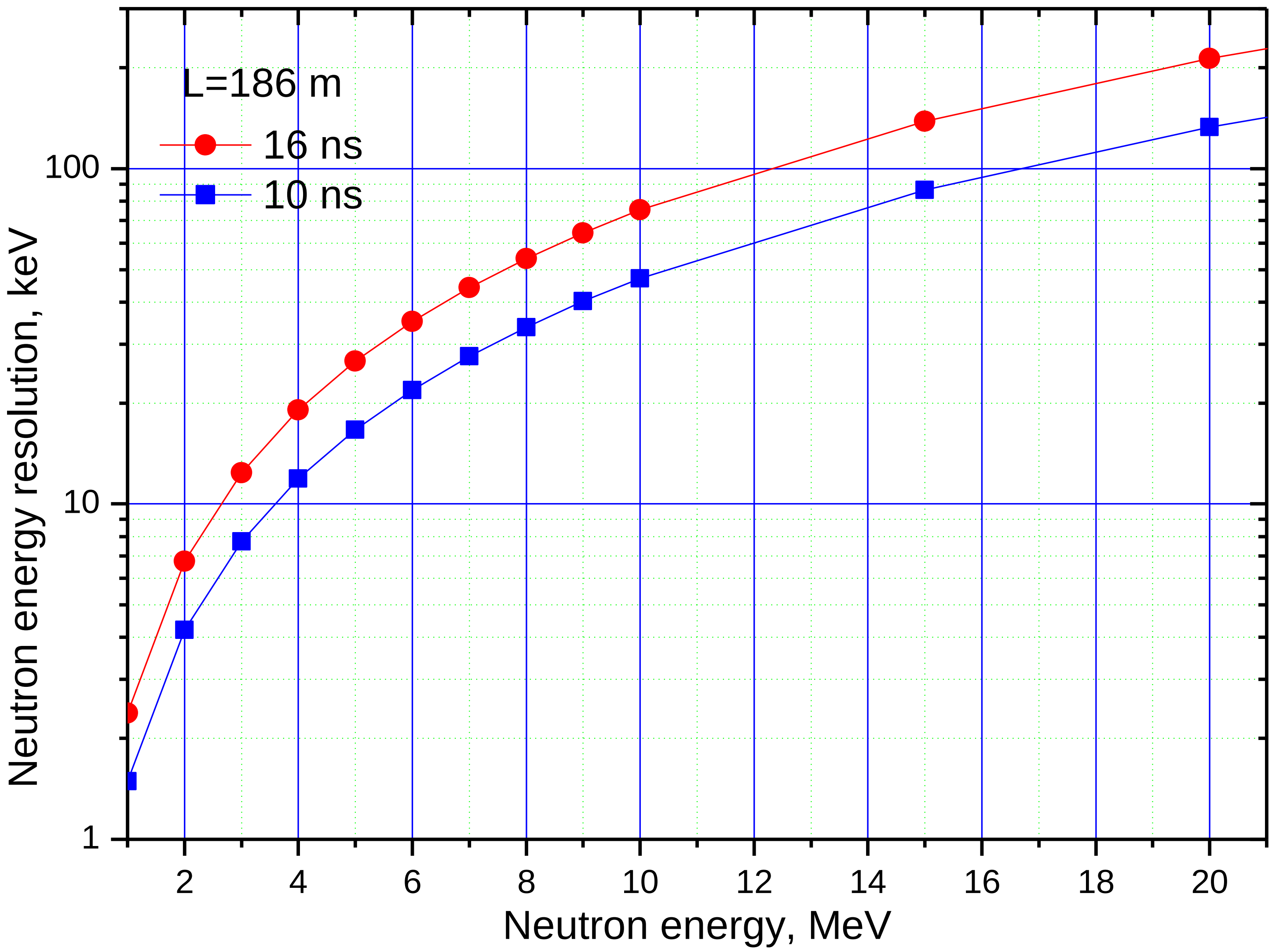




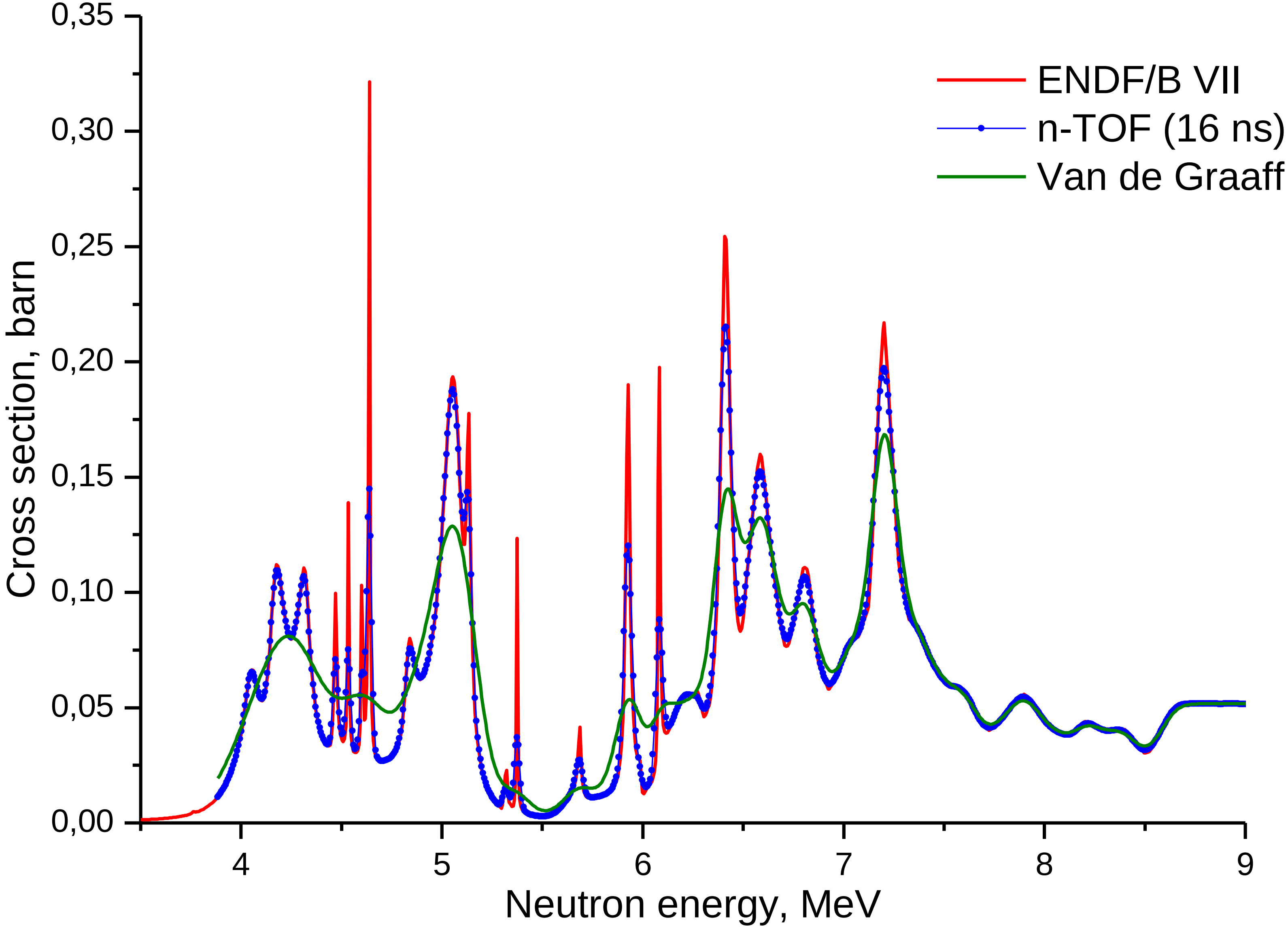
Time of flight, 186 m



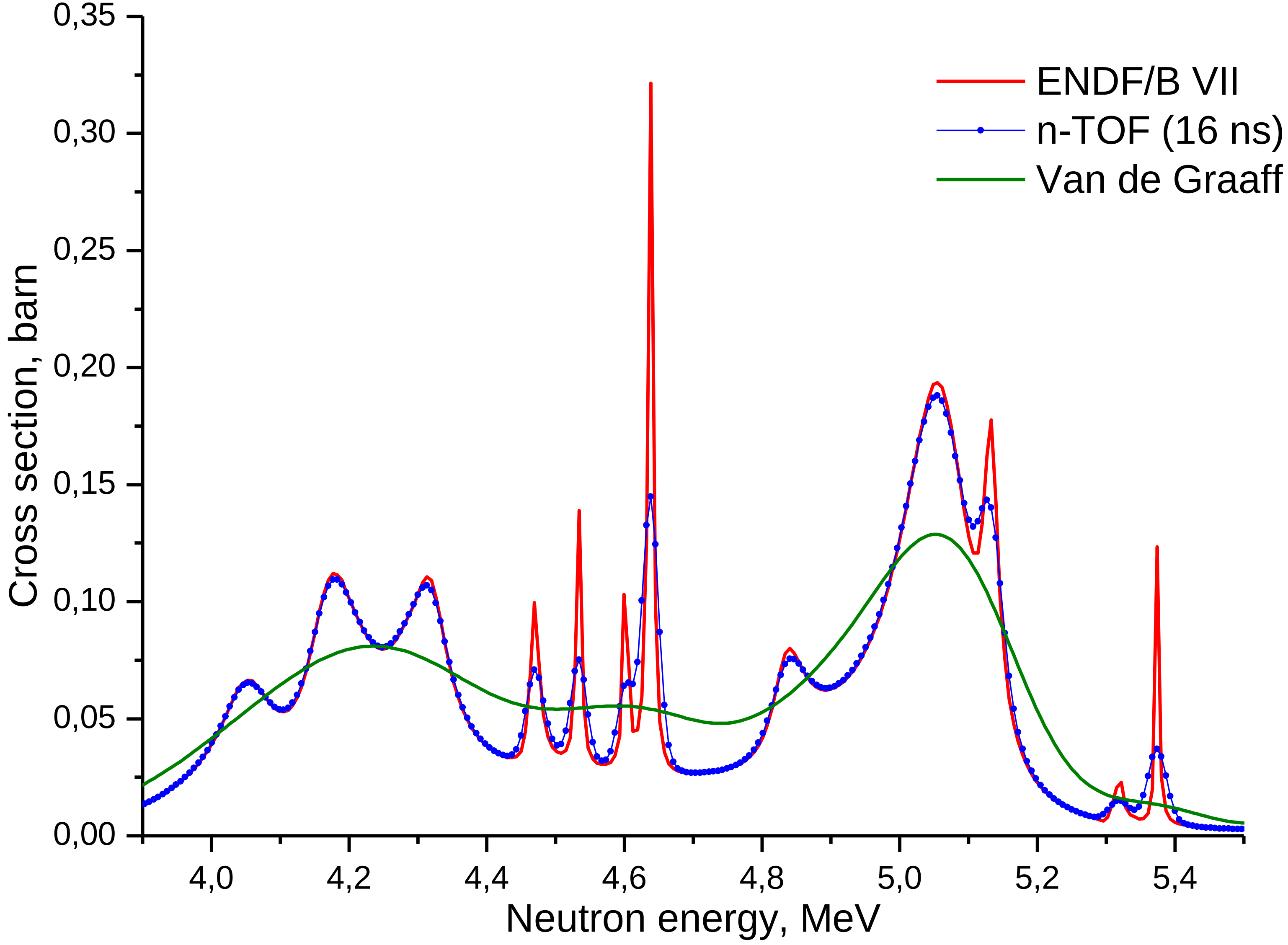
Timing resolution



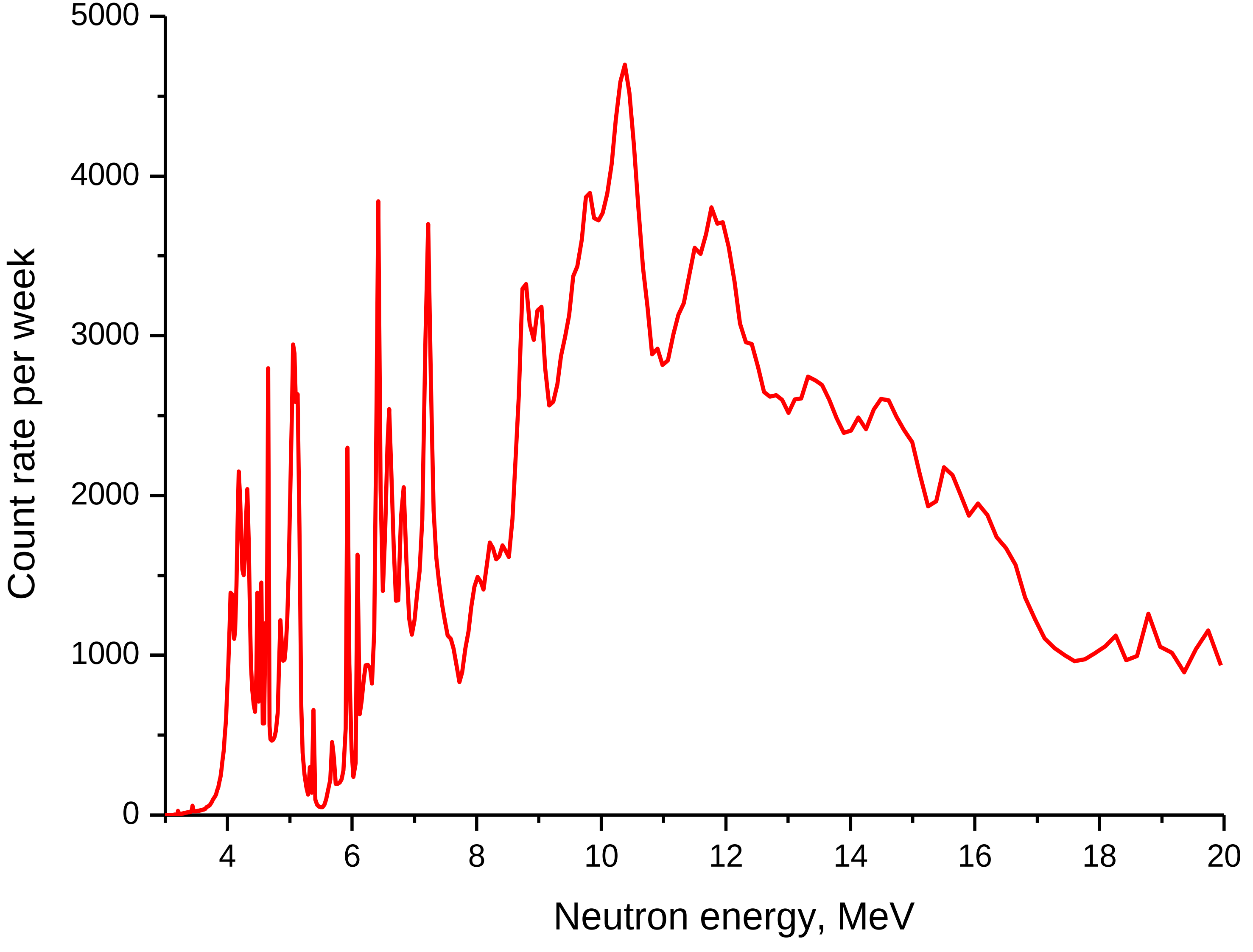
Energy resolution



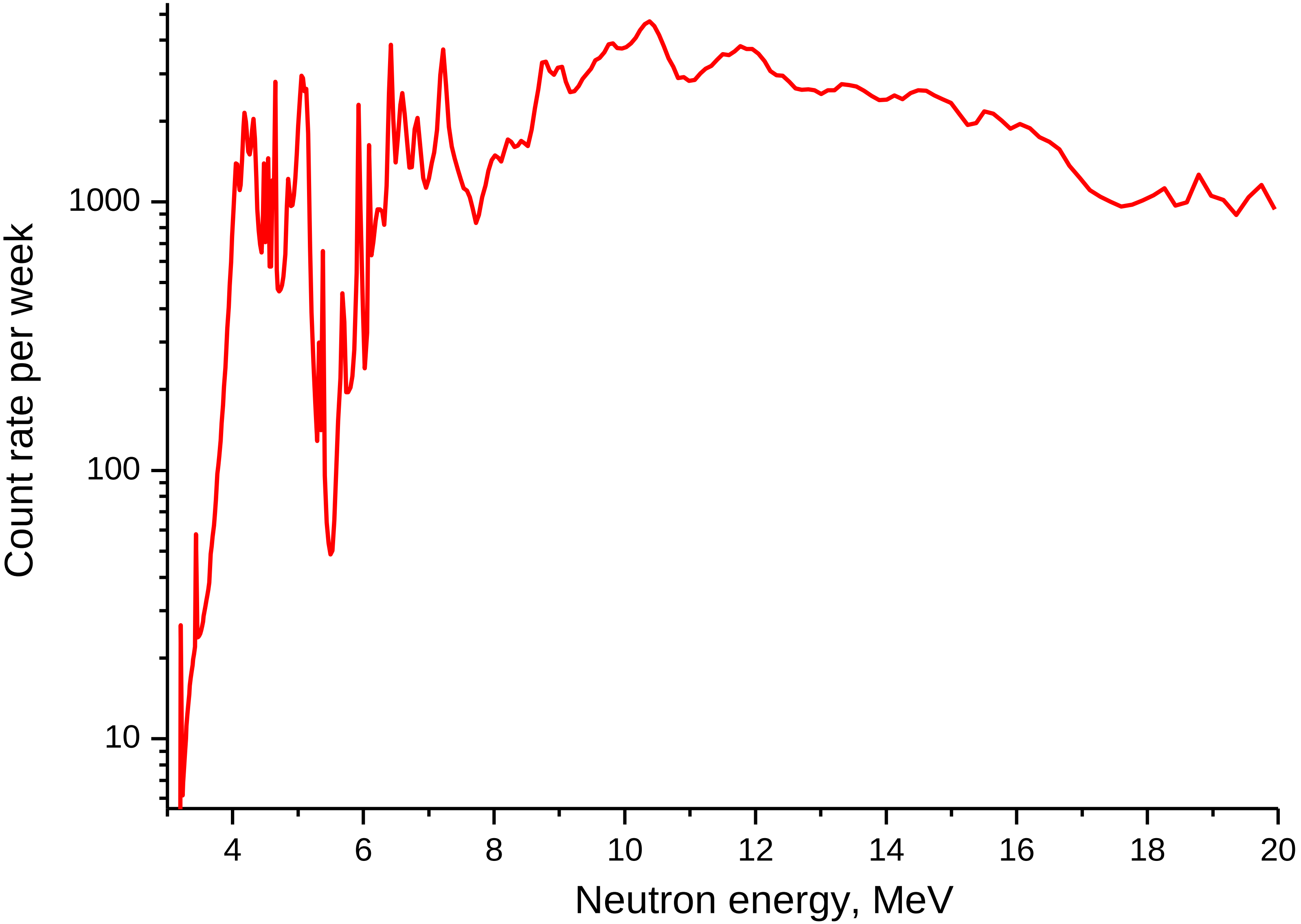
Energy resolution



Count rate. 0,2 g oxygen target.



Count rate. 0,2 g oxygen target.



Advantages of the method

- Dead time for main and monitor channel is equall
- The simple response function of the spectrometer
- Achieved a big mass of the target
- A simple method for determining the mass of non-radioactive target
- Developed numerical methods to effectively suppress backgrounds
- Wall effect is absent

Conclusion

- New data for $^{16}O(n,\alpha)^{13}C$ cross section is important for many applications. (n,α) reactions for ^{10}B, ^{12}C, ^{14}N, ^{19}F is also important.
- New technique used gaseous target and digital signal processing applied to ionization chamber was developed in IRMM-IPPE collaboration.
- It is possible to have up to 1 g target mass with zero thickness!
- Effective background suppression was developed using DSP methods.
- Using n-TOF facility and IPPE detector it is possible to investigate (n,α) reactions in energy region up to 20 MeV.
- Neutron energy spread will be significant less then for Van der Graaf experiments.
- Break up reactions (3 particles in output channel) can also be investigated.

Thank you for your attention!