^{10}B-RPC based neutron detectors

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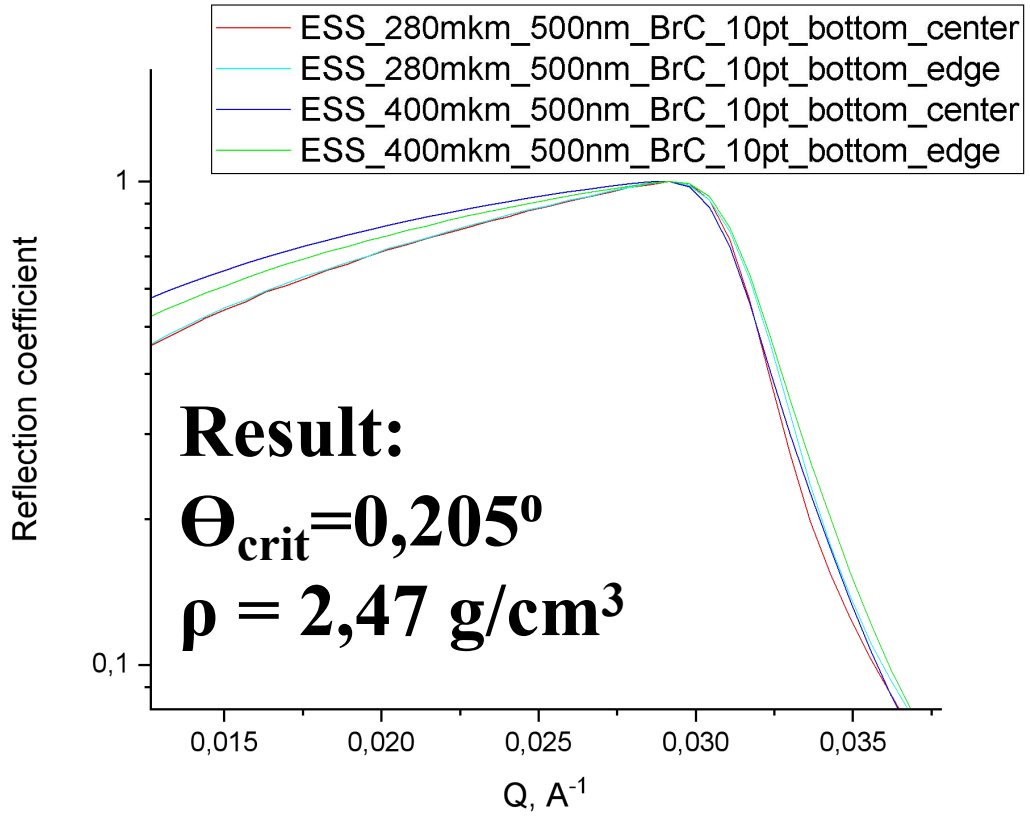
Reasons for developing of ^{10}B-RPC based neutron detectors:

$$\left(\frac{\Delta k_{\perp}}{k_{\perp}}\right)^2 = \left(\frac{\Delta\Theta}{\Theta}\right)^2 + \left(\frac{\Delta\lambda}{\lambda}\right)^2$$

- Increasing the resolution of operating neutron scattering facilities;
- Increasing couting rate capacity for detectors of new generation of neutron sources;
- Lower cost of ^{10}B based detectors per unit area compared to ^{3}He.

Magnetron sputtering of thin films $^{10}B_4C$

Sputtered at ESS Linkoping Workshop:
0.5, 1 and 2 µm ±10% of B_4C by CemeCon CC800/9 (400ºC)



Cu tube of X-Ray diffractometere EMPYREAN:
1,540580 Å/1,5444260 Å = 2

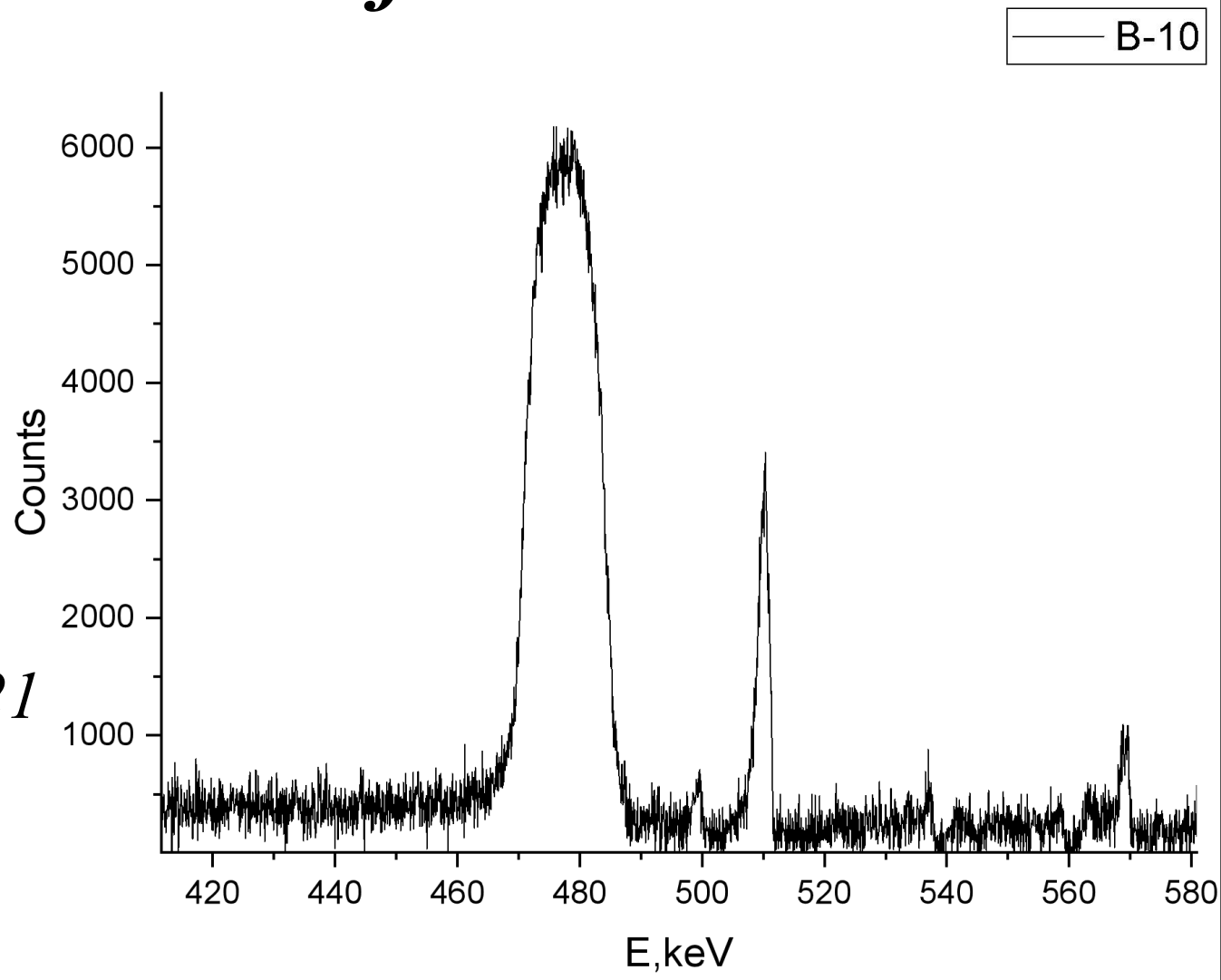
First step of detector characterization was measuring of gamma spectrum from neutron conversion reaction:

$$^{10}B + n \rightarrow \alpha + {}^{7}Li + \gamma\ (93.7\%),$$

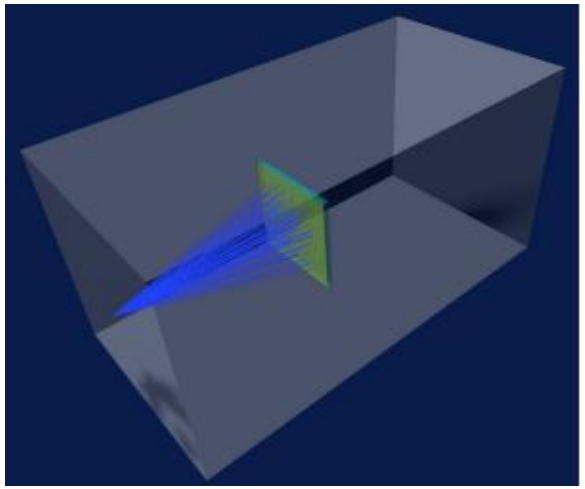
$$^{10}B + n \rightarrow \alpha + {}^{7}Li\ (6.3\ \%)$$

$$\sigma_{abs}(E_n=25meV)=3837b$$

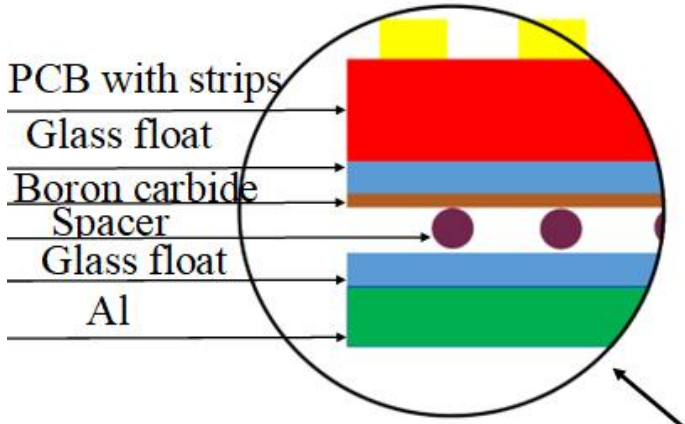
Measured by HPGe Canberra GC10021 with ^{252}Cf neutron source is placed in HDPE and lead shielding

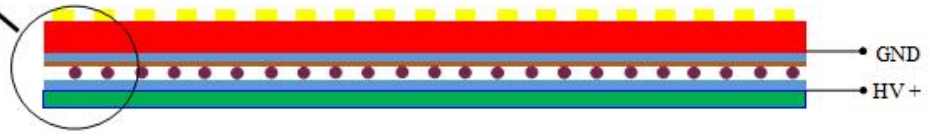


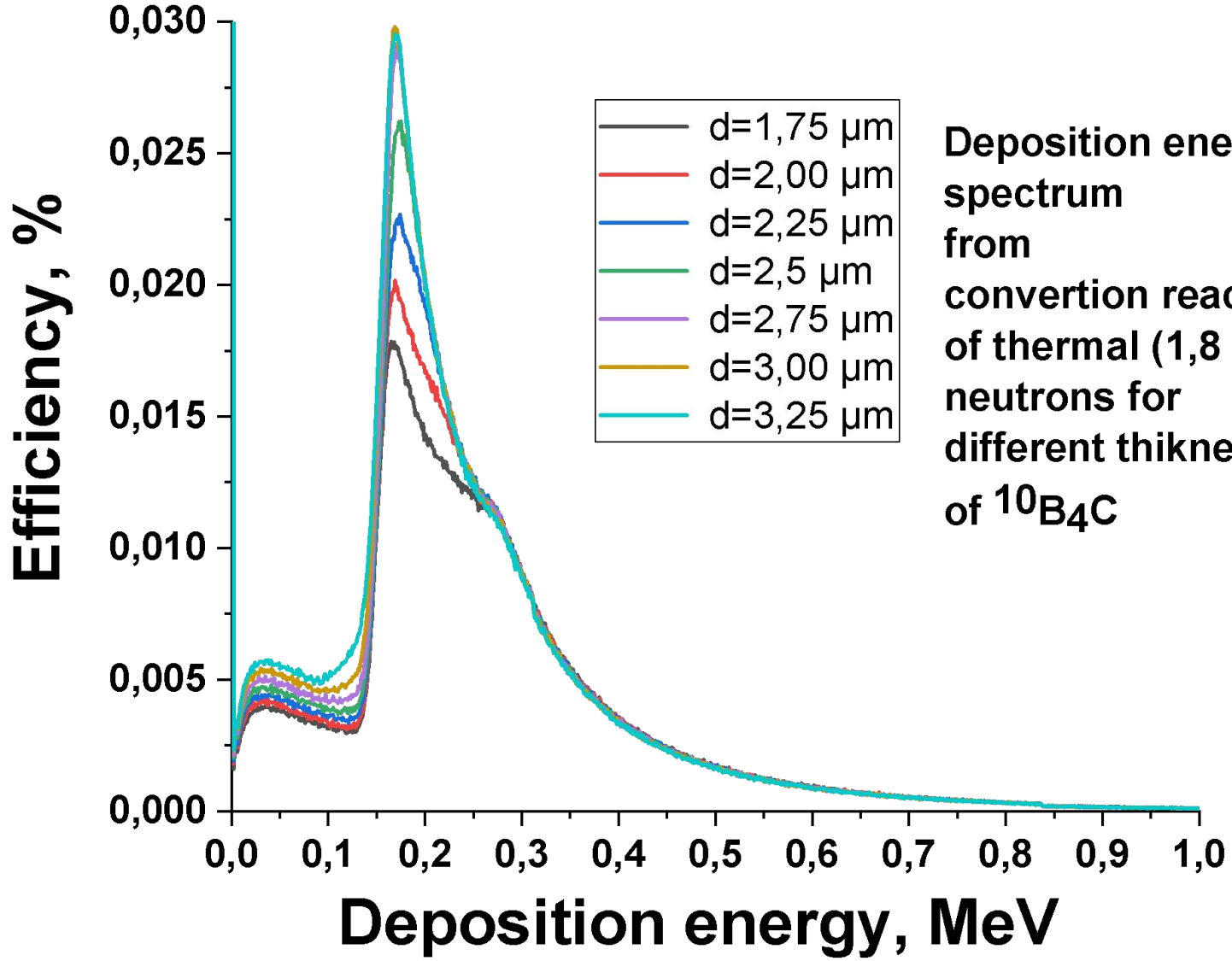
Geant4 Monte-Carlo simulation



Geant4 model



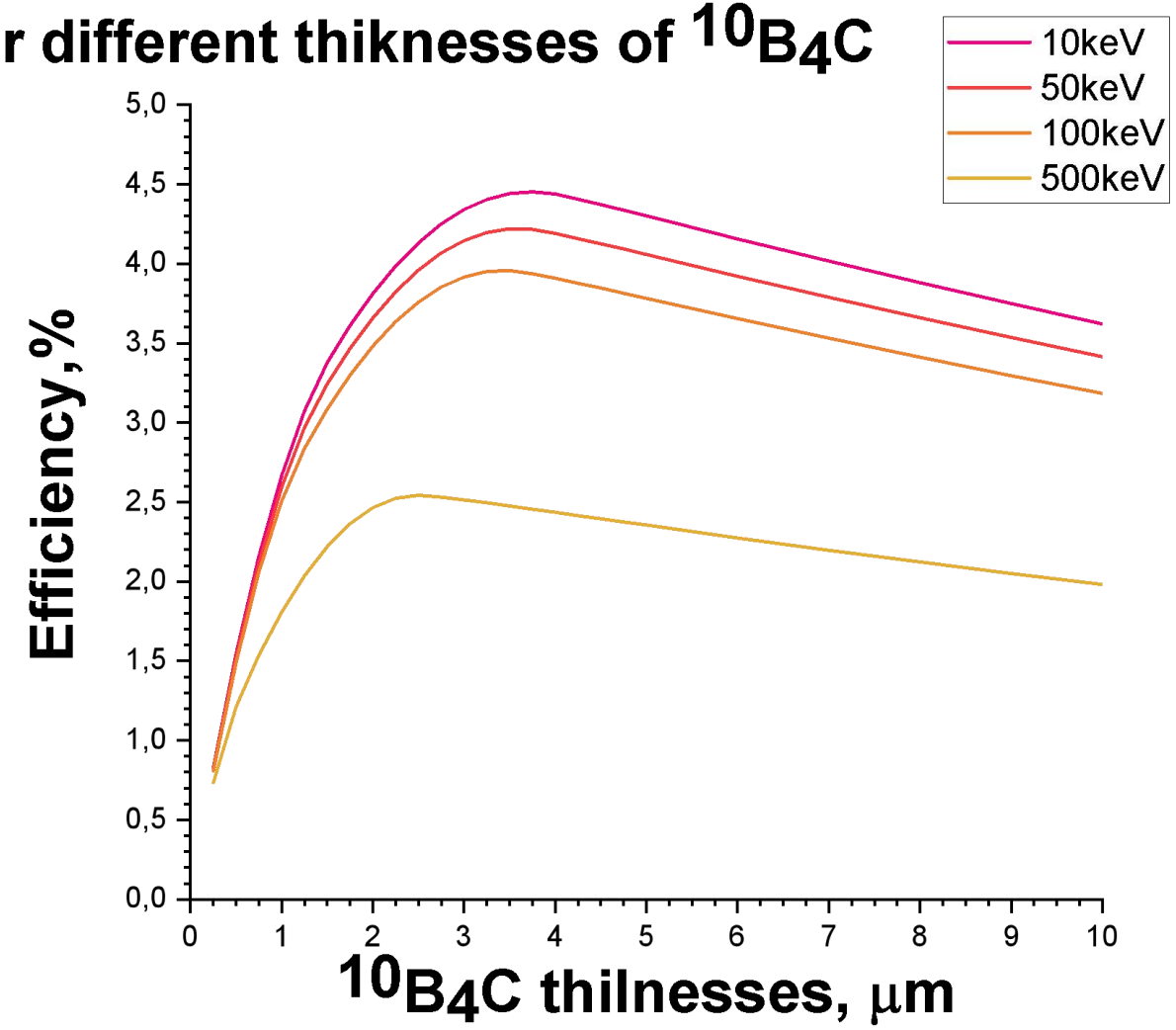


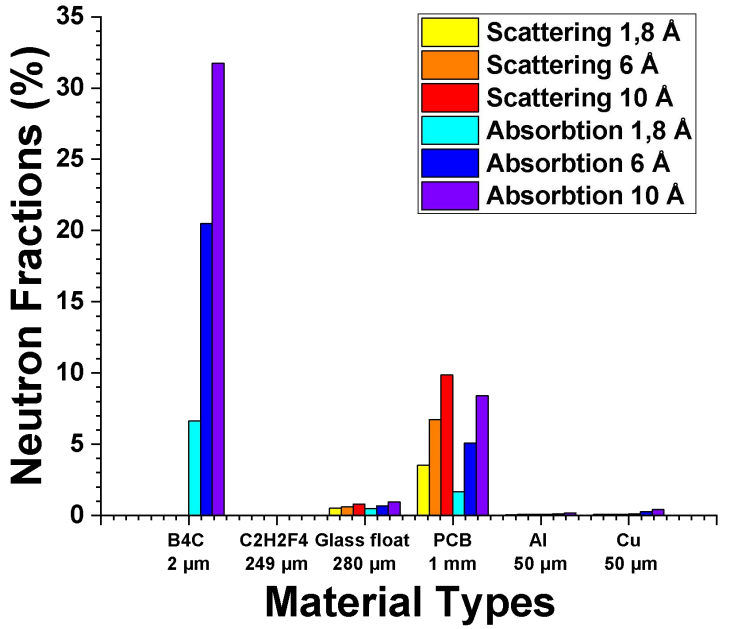


Deposition energy spectrum from convertion reaction of thermal (1,8 Å) neutrons for different thiknesses of $^{10}B_4C$

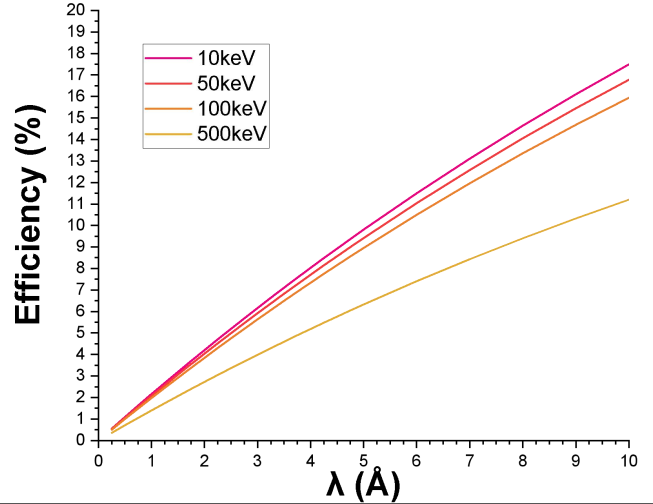
Geant4 Monte-Carlo simulation

Convertion efficiency of thermal (1,8 Å) neutrons for different thiknesses of $^{10}B_4C$

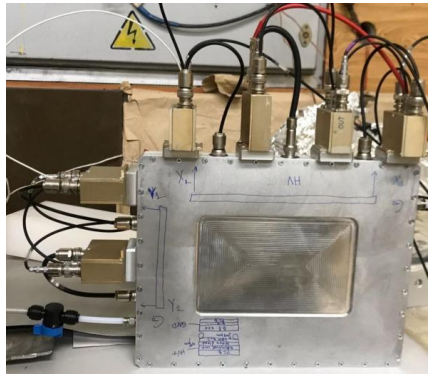


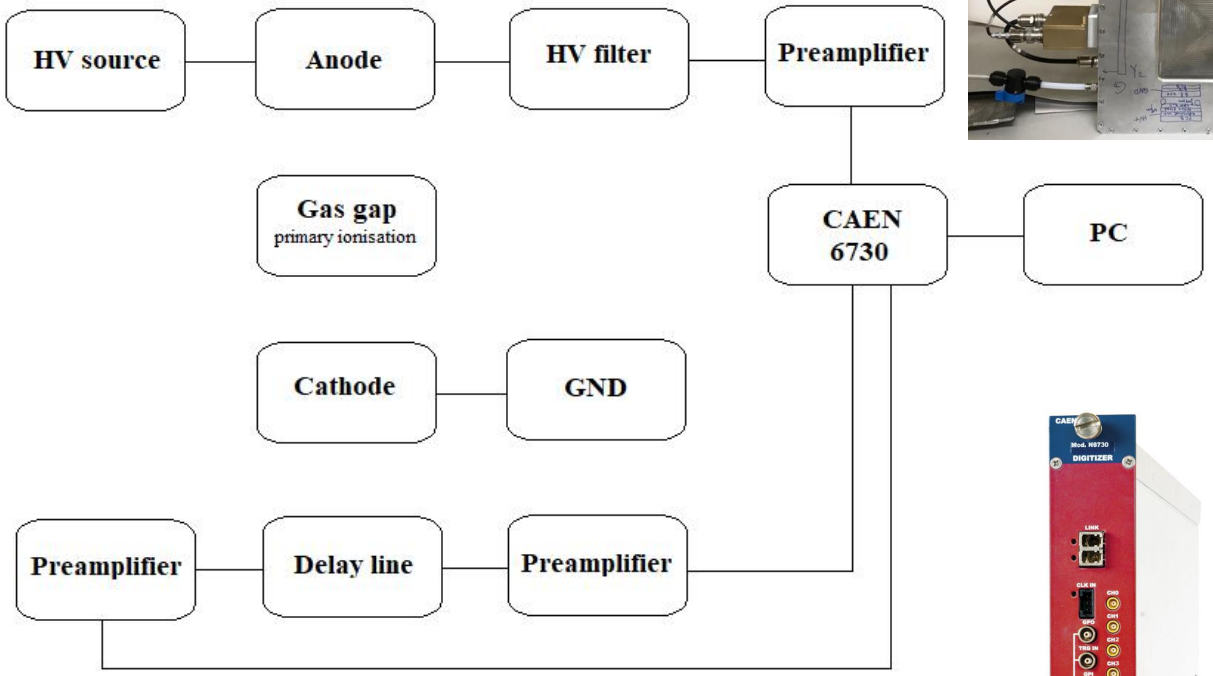


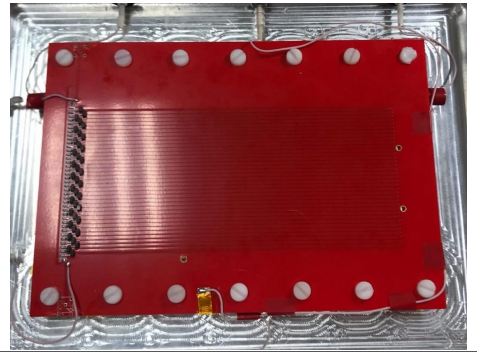
Conversion efficiency for different neutron waveleght and $^{10}B_4C$ thikness 2 μm

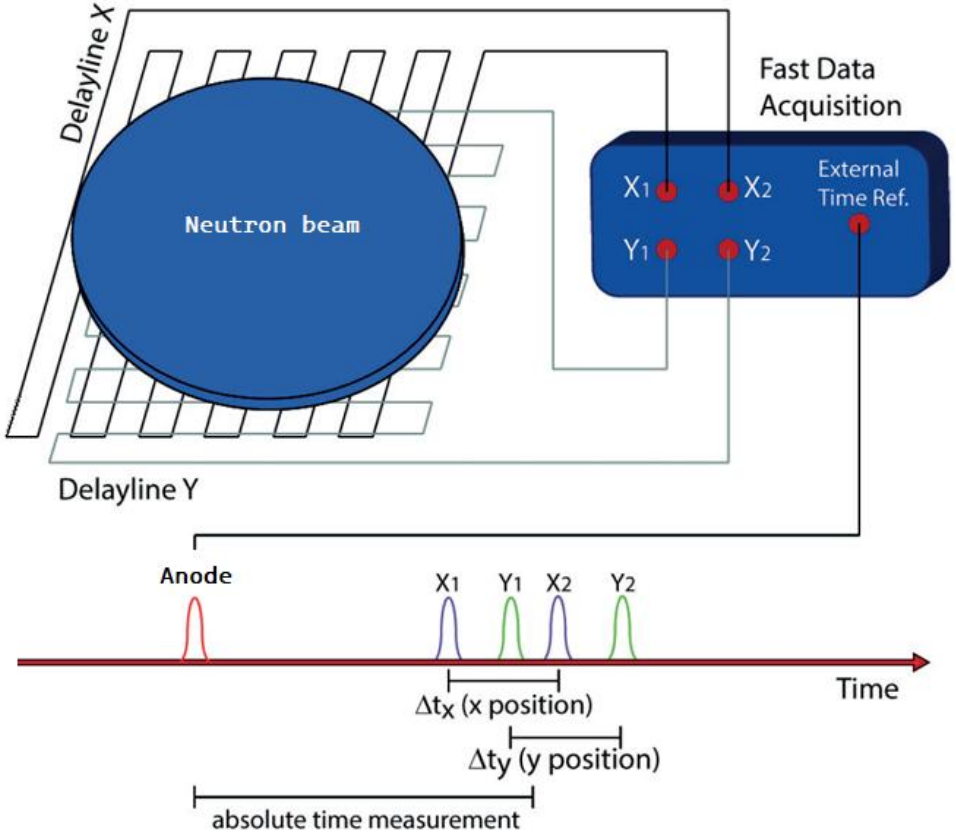


Produced 1D-PSD of thermal neutrons based on ^{10}B-RPC



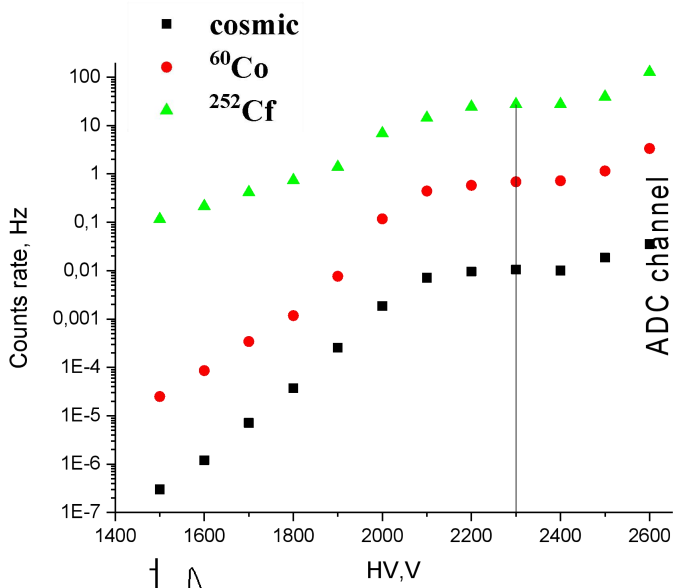


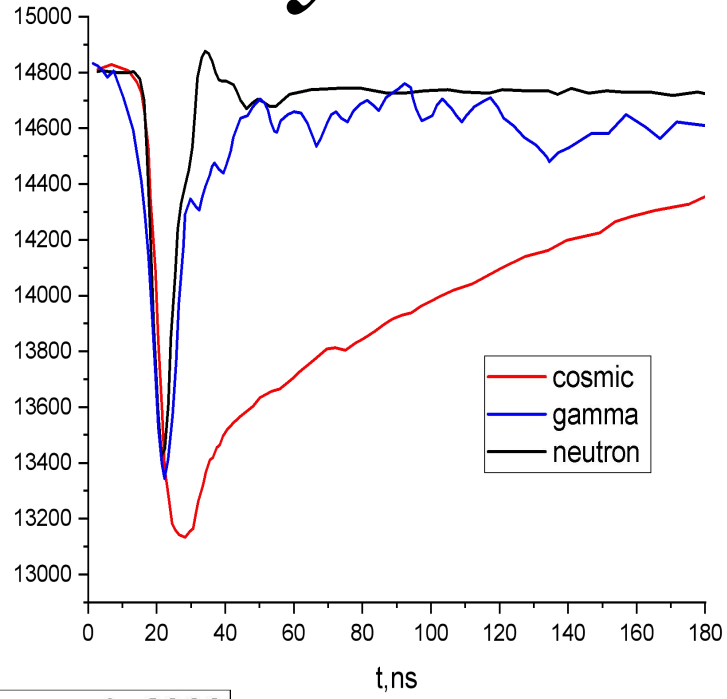


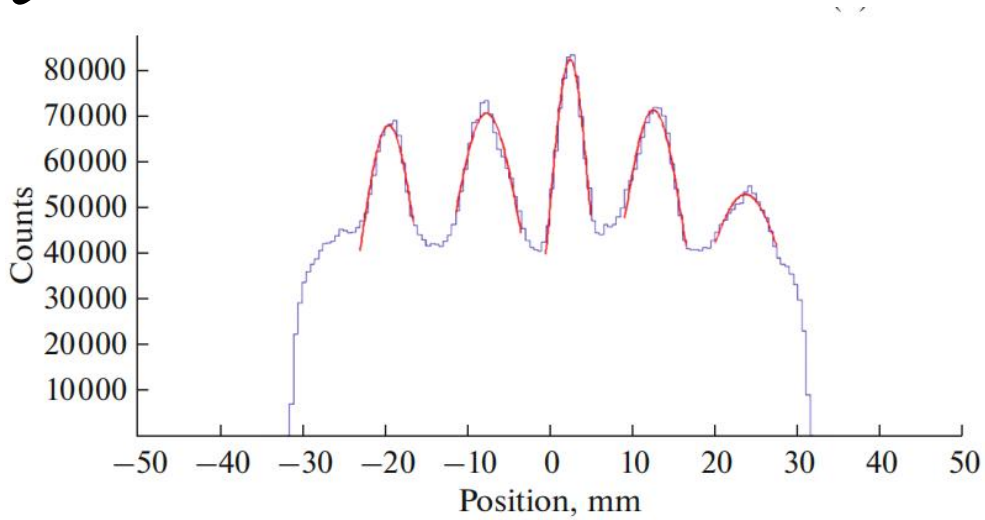


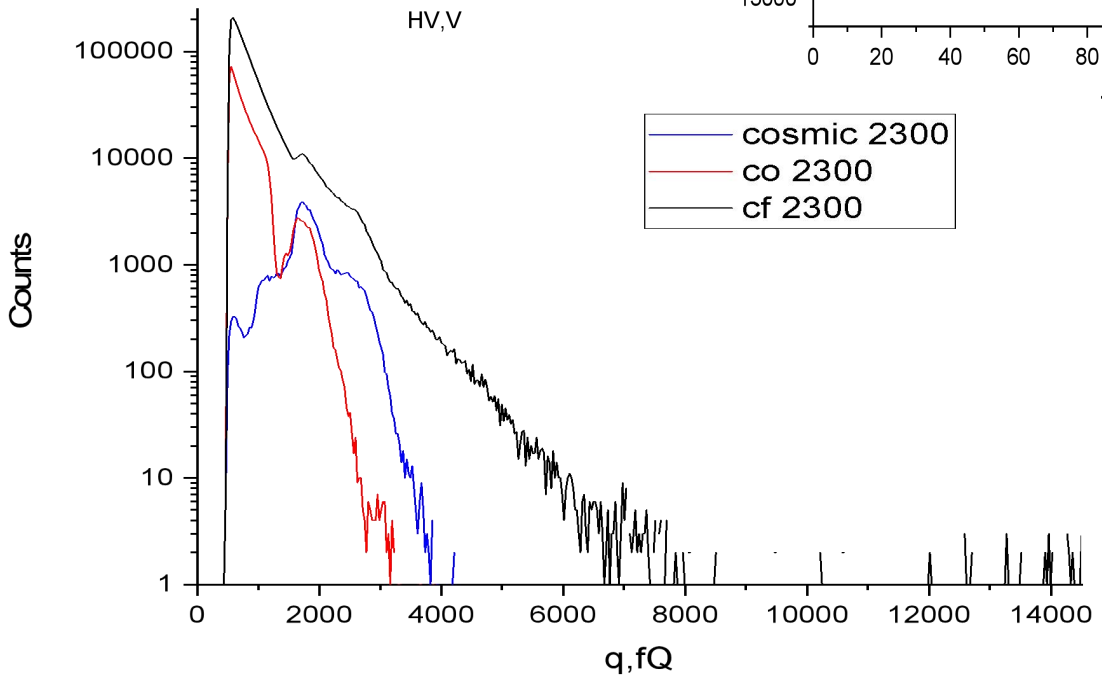
C=39pF, L=95 nGn

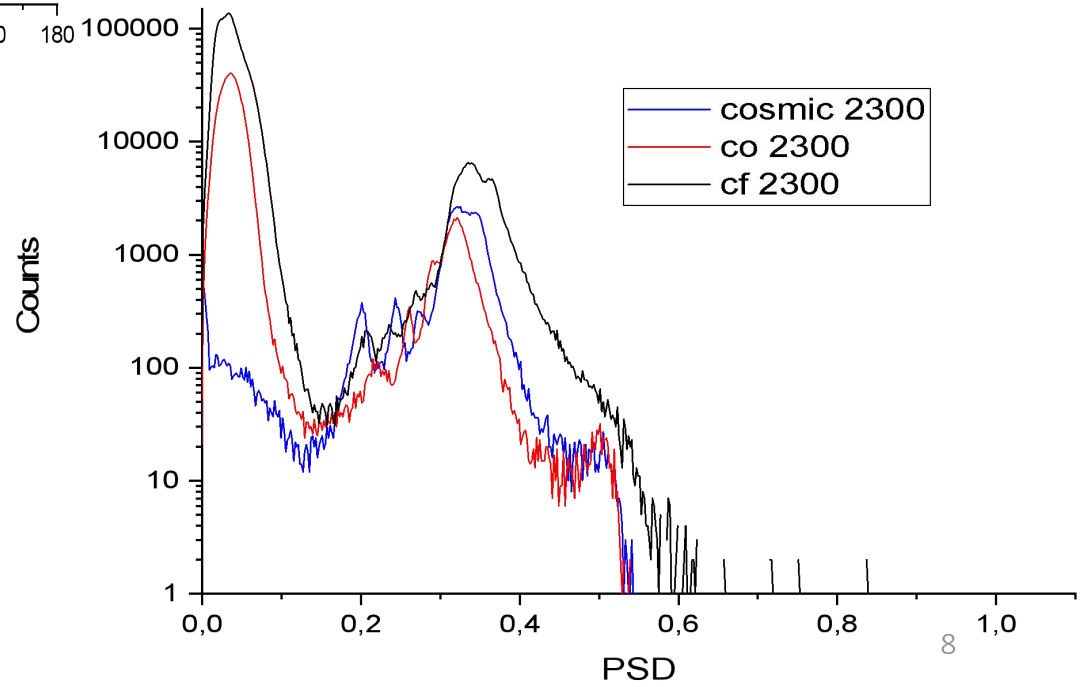
Characterization by laboratory sources



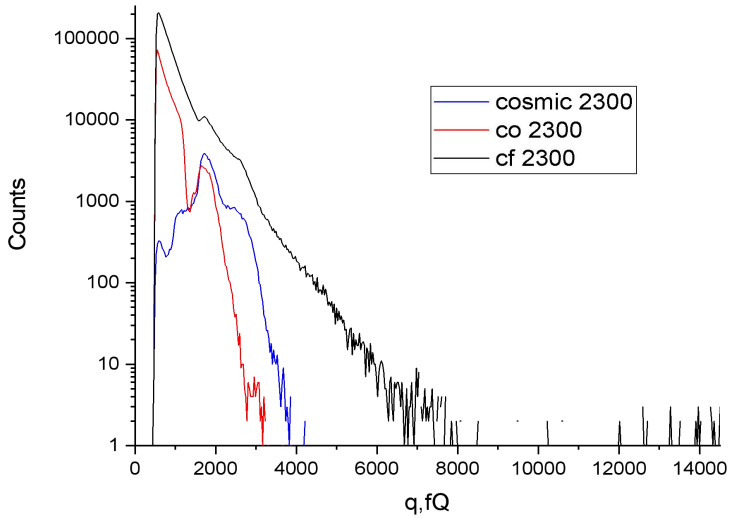


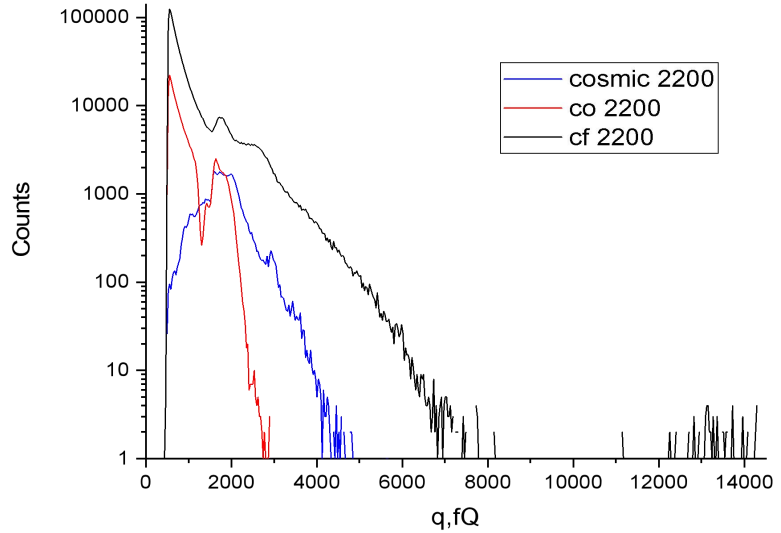


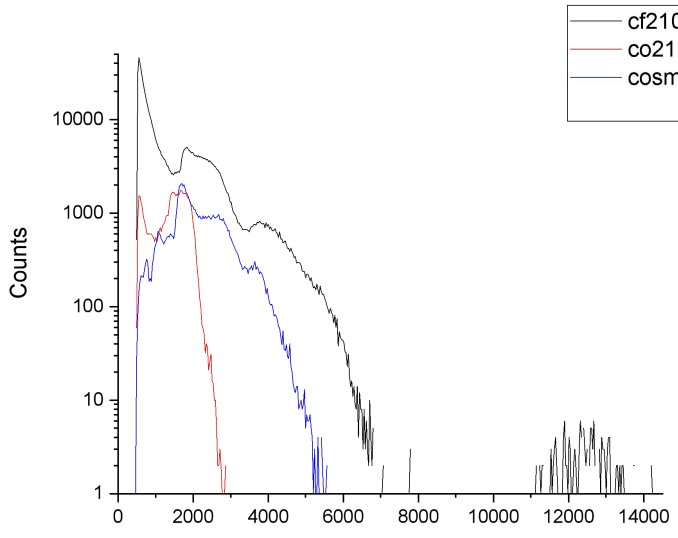


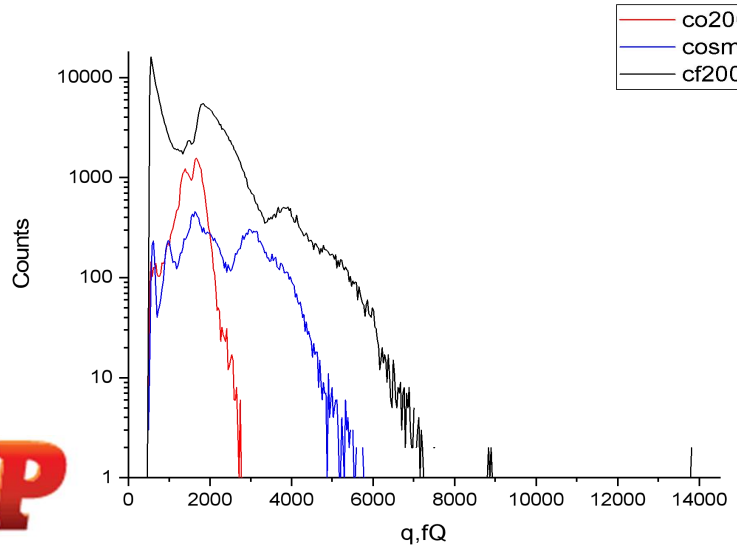


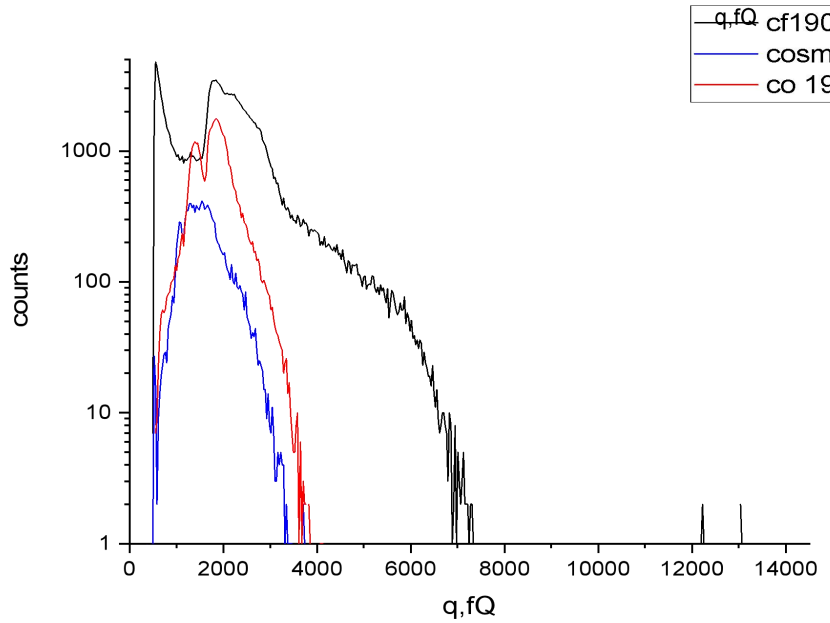
Charge spectra from laboratory sources at different applied voltages



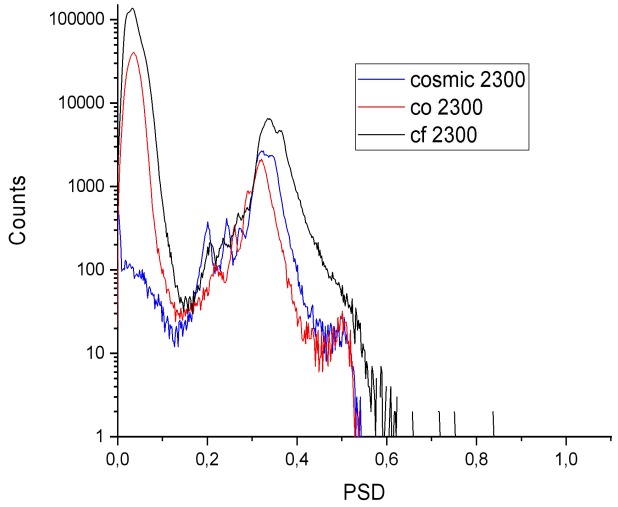


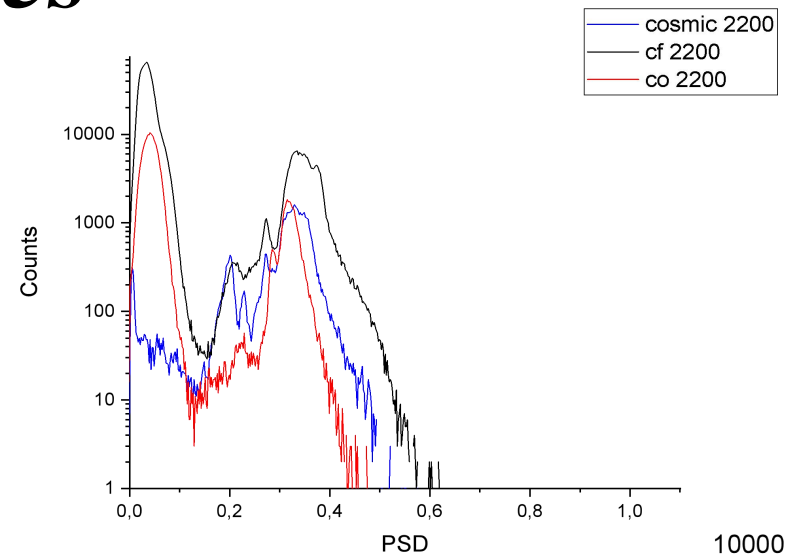


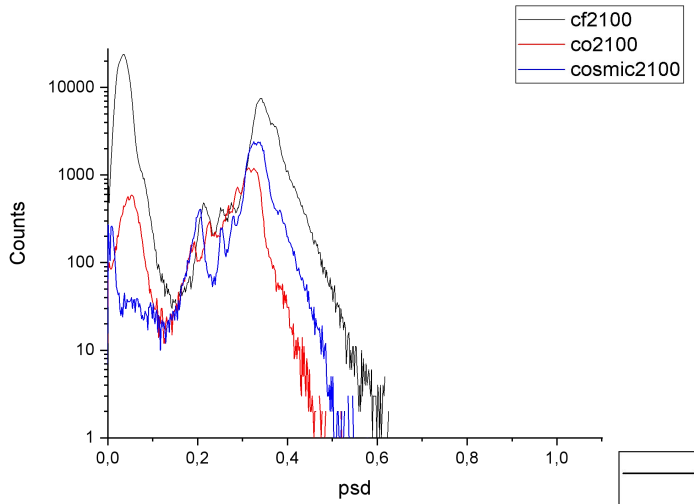


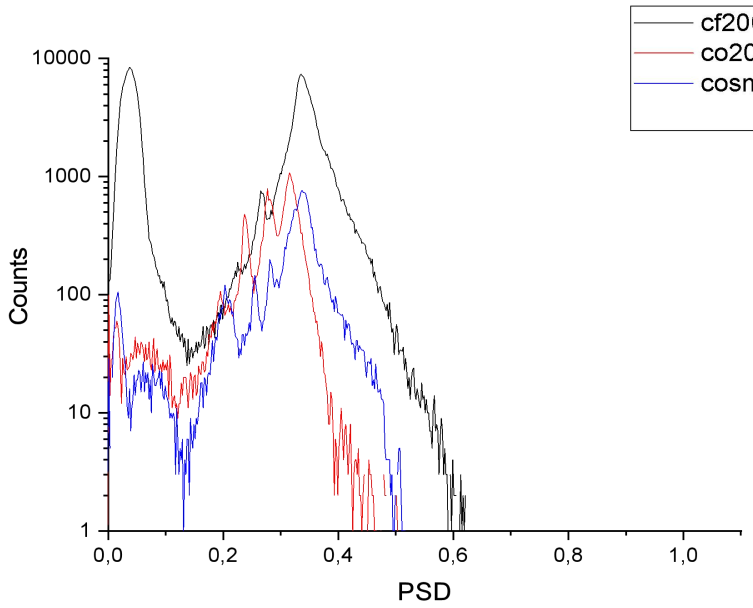


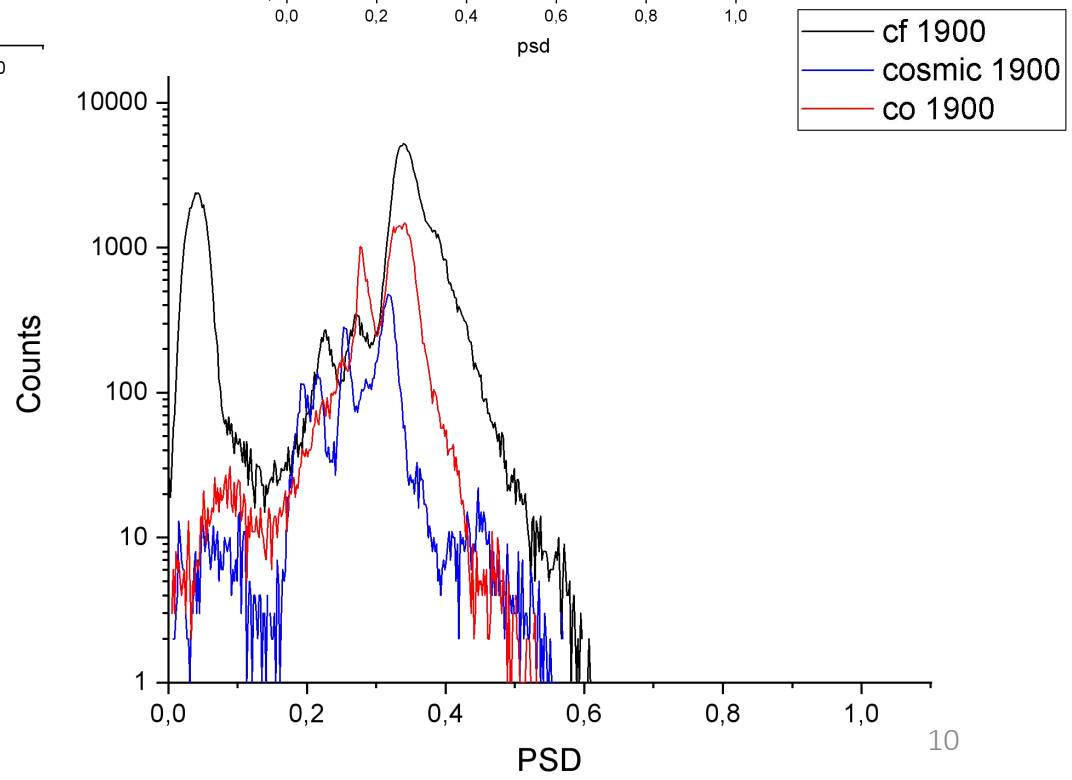
PSD spectra from laboratory sources at different applied voltages



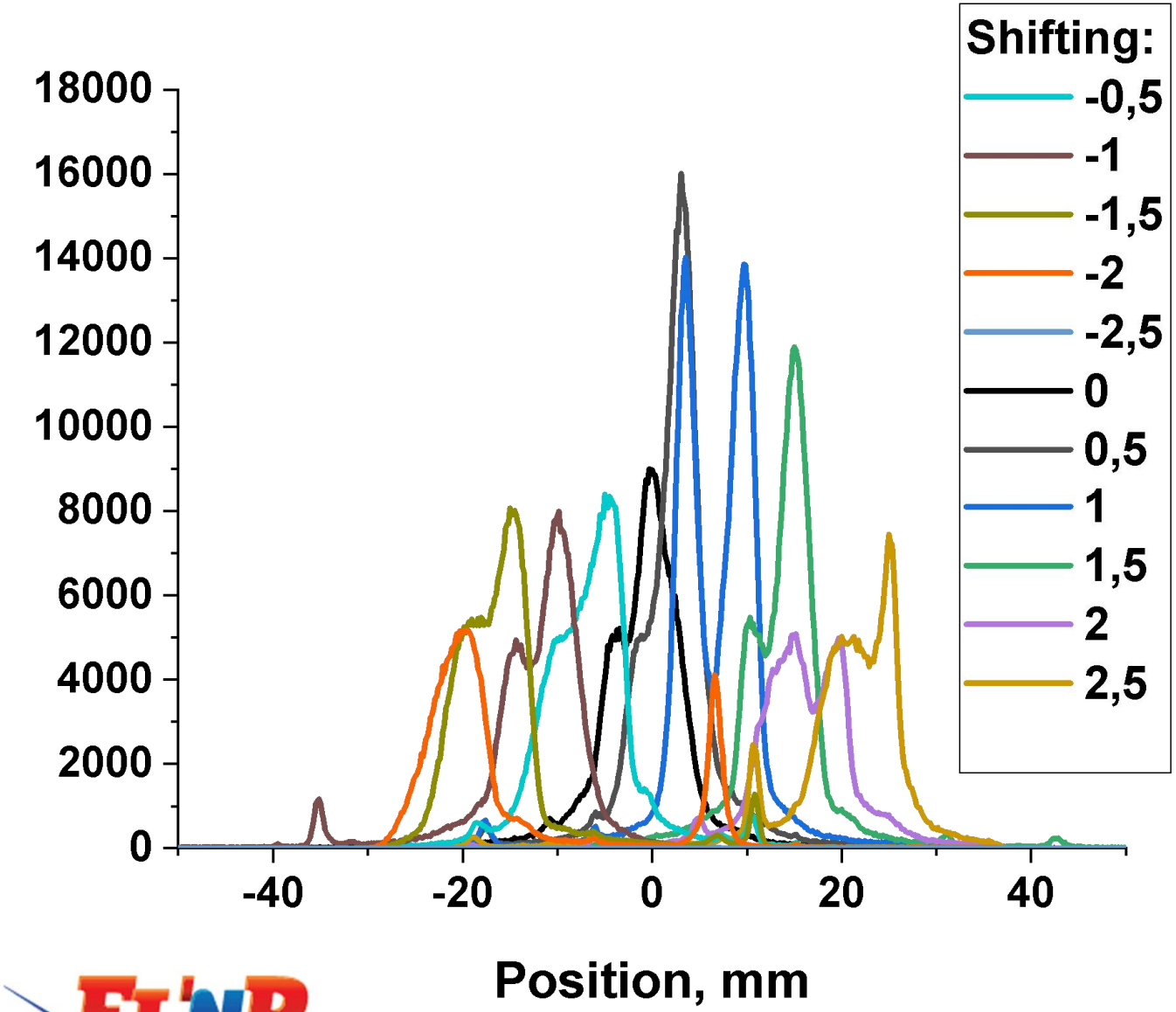


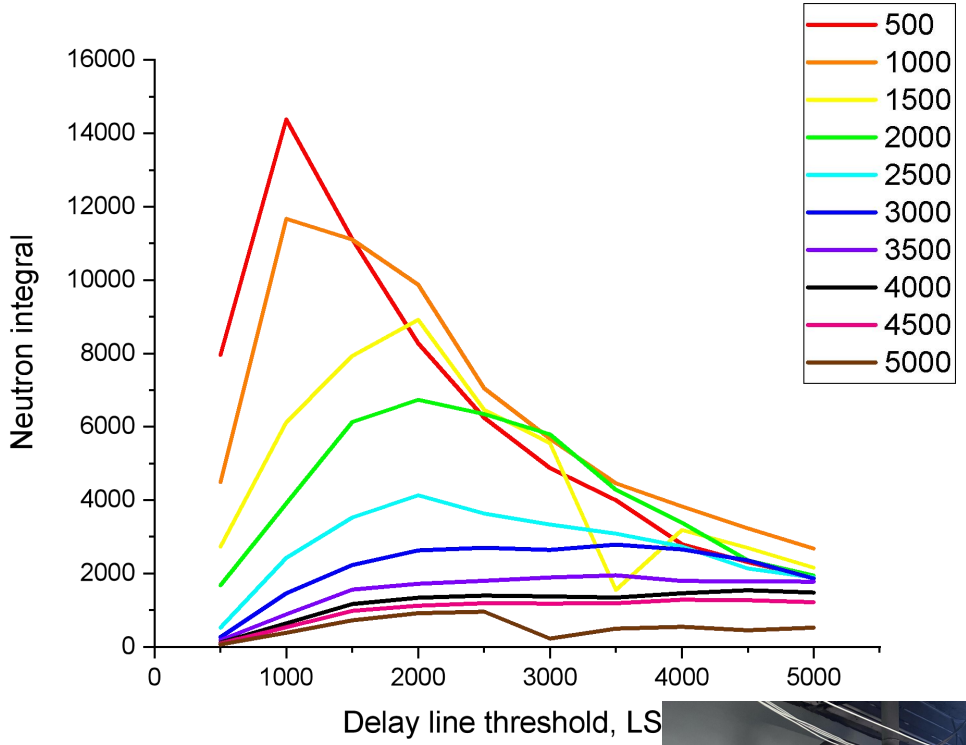


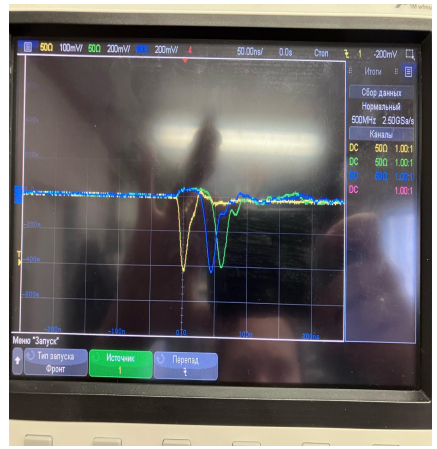


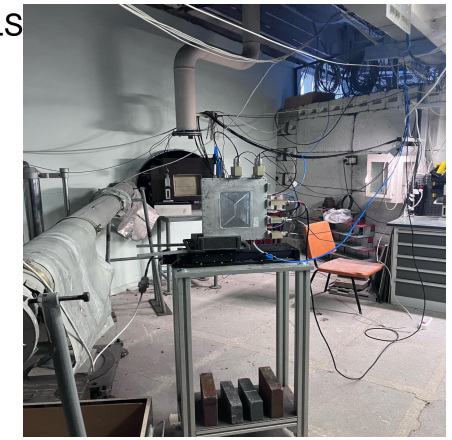


Measuring on channel №9 of IBR-2









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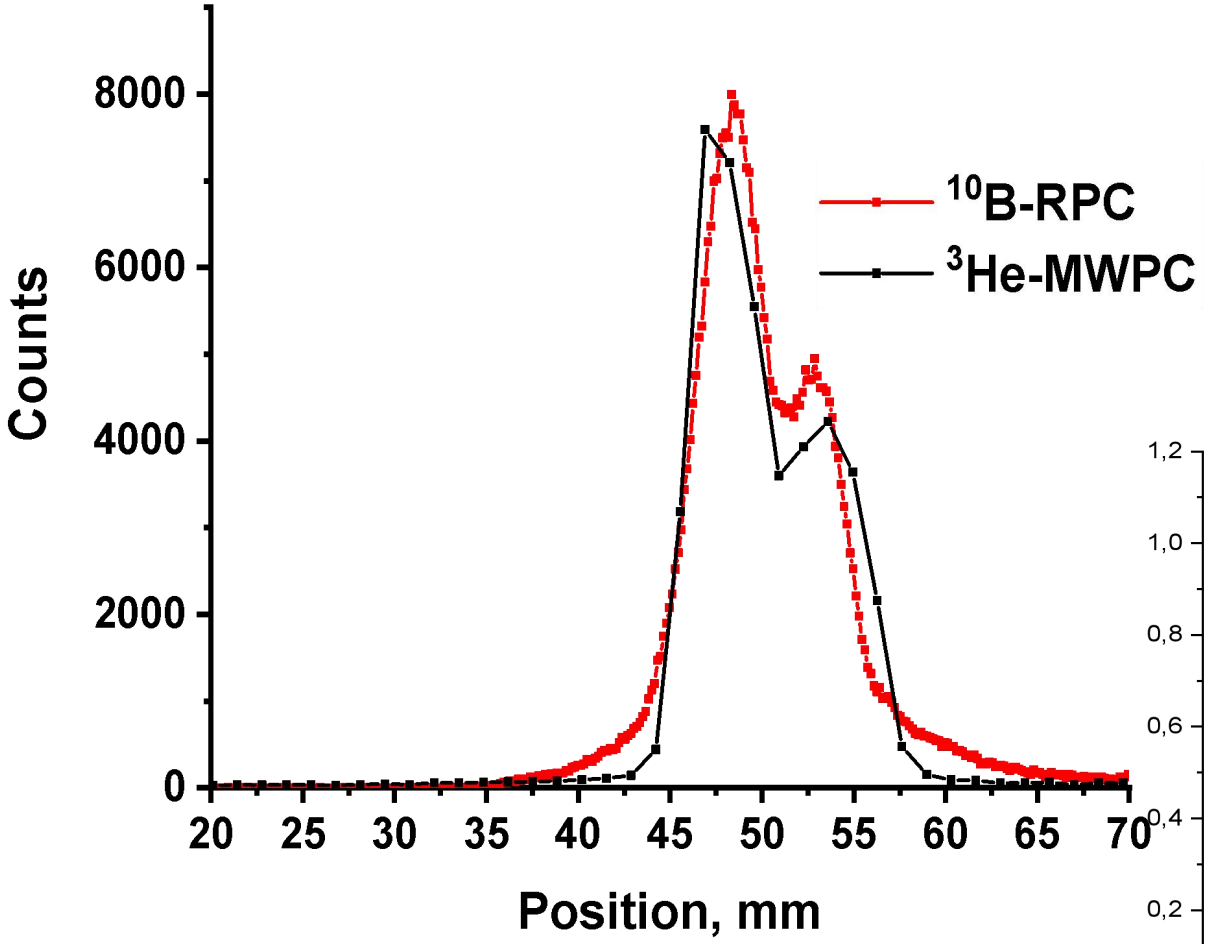
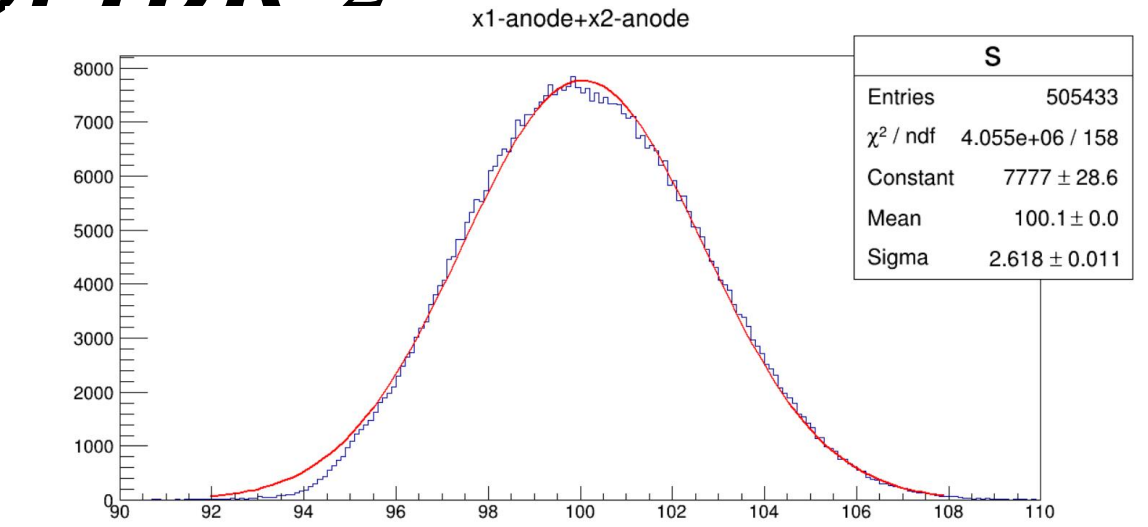
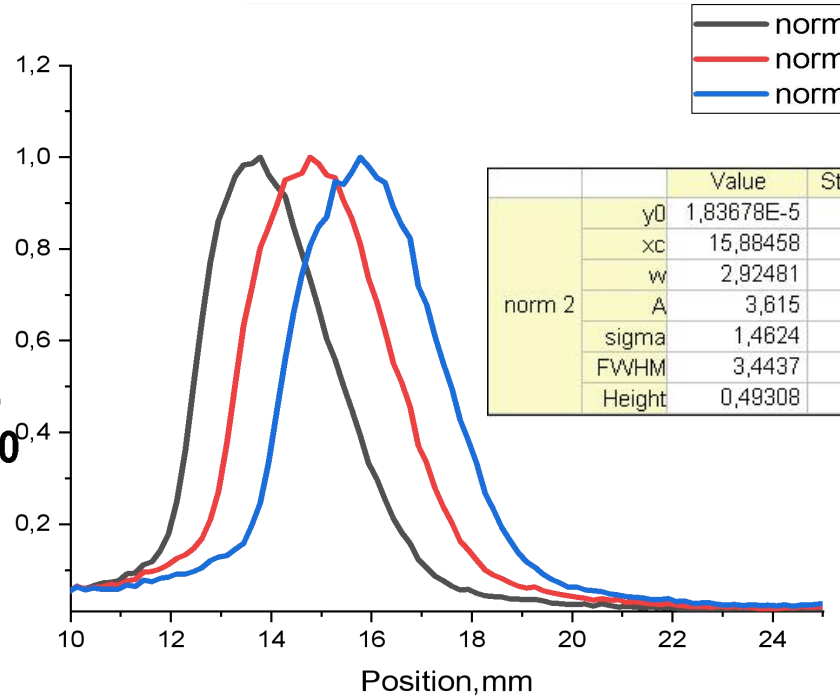






		Value	Standard Error	t-Value	Prob>|t|	Dependency
norm 2	y0	1,83678E-5	1,24299E-6	14,77712	0	4,46699E-5
	xc	15,88458	6,75527E-4	23514,34814	0	1,82077E-14
	w	2,92481	0,00135	2164,82081	0	0,33334
	A	3,615	0,00145	2499,67998	0	0,33336
	sigma	1,4624	6,75531E-4			
	FWHM	3,4437	0,00159			
	Height	0,49308	1,97255E-4			

Next step is increasing of thermal neutrons registration efficiency

Find by maximum likelihood estimation (MLE) thiknesses of $^{10}B_4C$:

№1: 850 μm

№2–13:1000 μm

№14–17:1100 μm

№18:1150 μm

№19–22:1250 μm

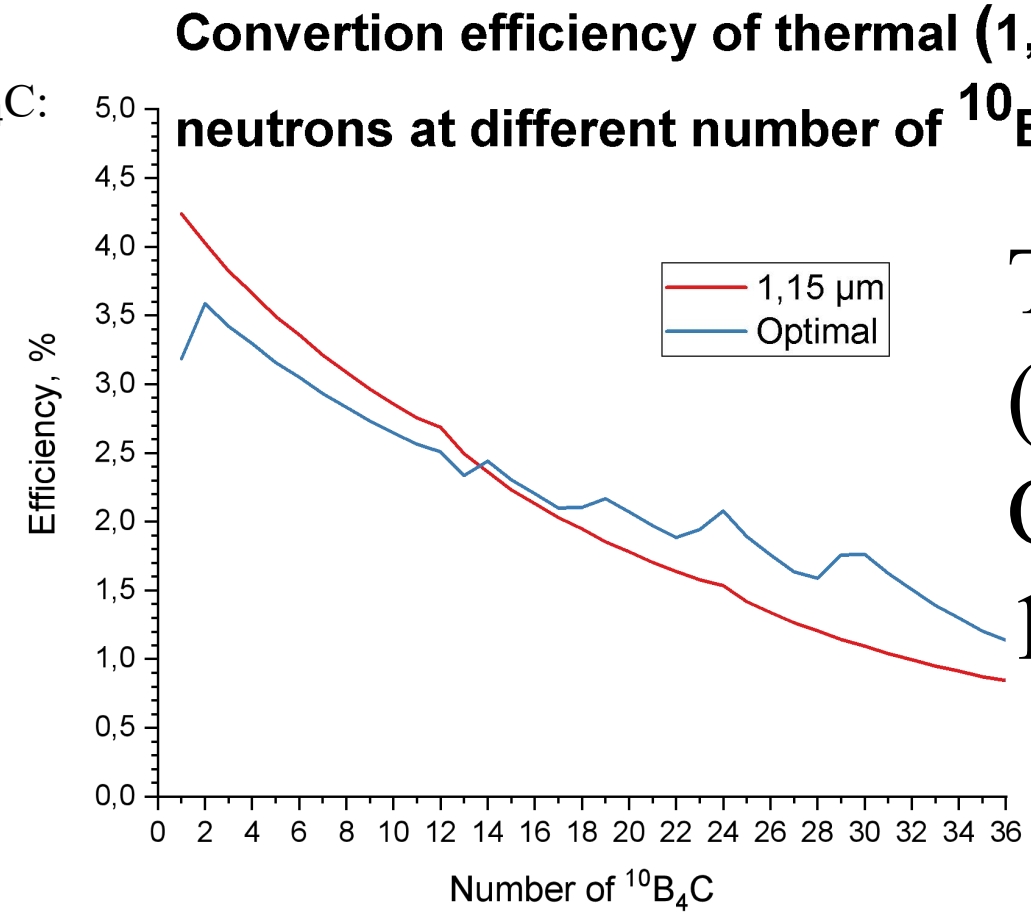
№23:1350 μm

№24–27:1500 μm

№28:1550 μm

№29:1850 μm

№30–36: 2000 μm



Total efficiency (1.8 Å):

Optimal 58,58 %

1,15μm 57,41 %

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