BRNO UNIVERSITY OF TECHNOLOGY

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JOINT INSTITUTE FOR NUCLEAR RESEARCH

Comparison of Experimental and Calculated Neutron Flux in Co-59 at the Spallation Target *QUINTA*

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Energy and Transmutation- RAW

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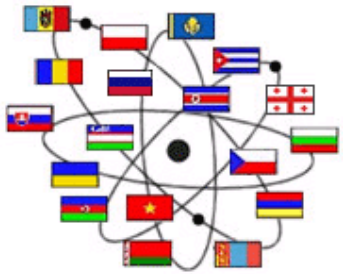
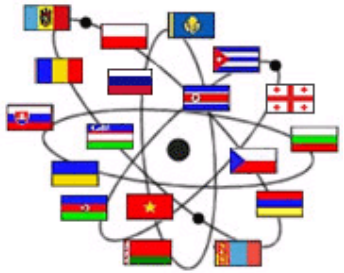




Introduction

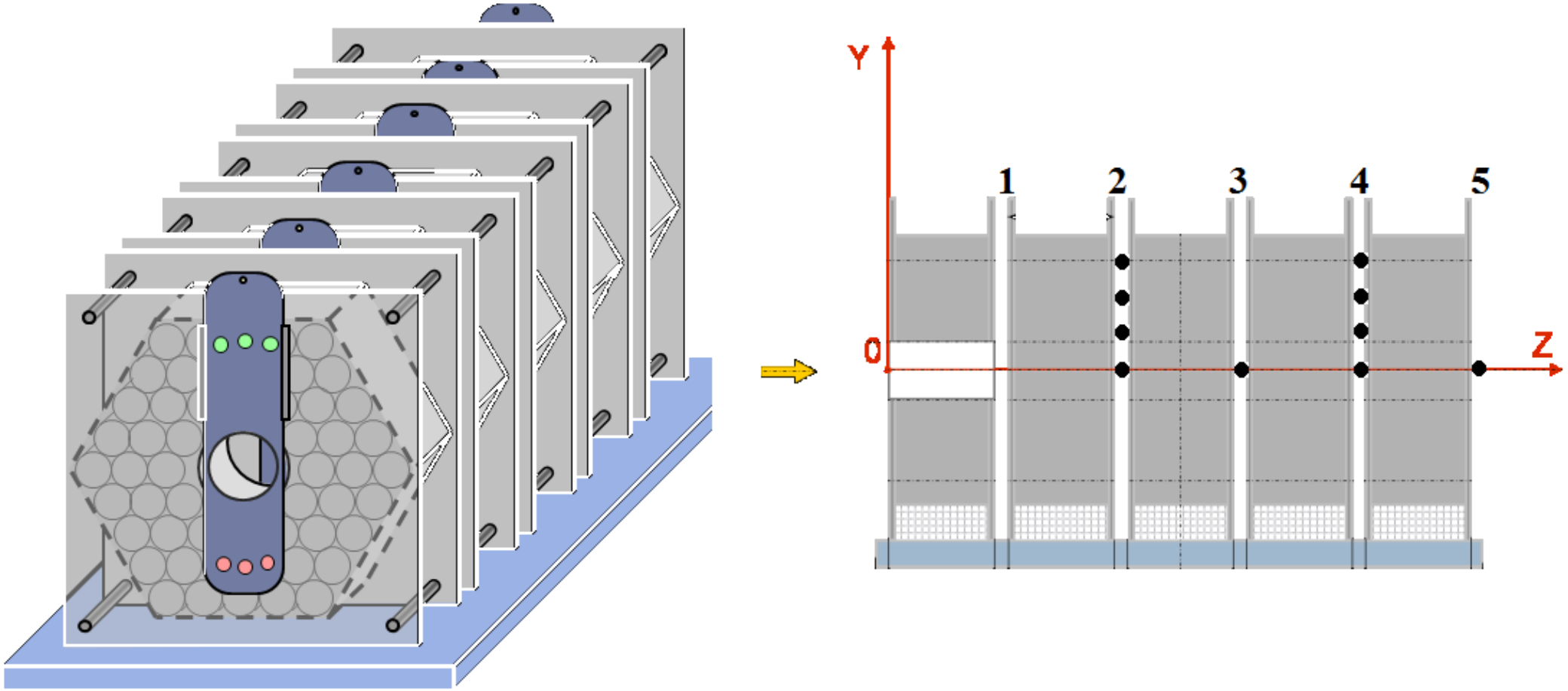
- One of the biggest problem of nuclear energy is radioactive waste. Each year, nuclear power facilities produce about 10 000 m^3 of high-level waste worldwide. One of the possibilities how to deal with nuclear waste is using ADS. Very important parameter of ADS is neutron flux.

- Worldwide research: MYRRHA(Belgium) E_p = 600 MeV

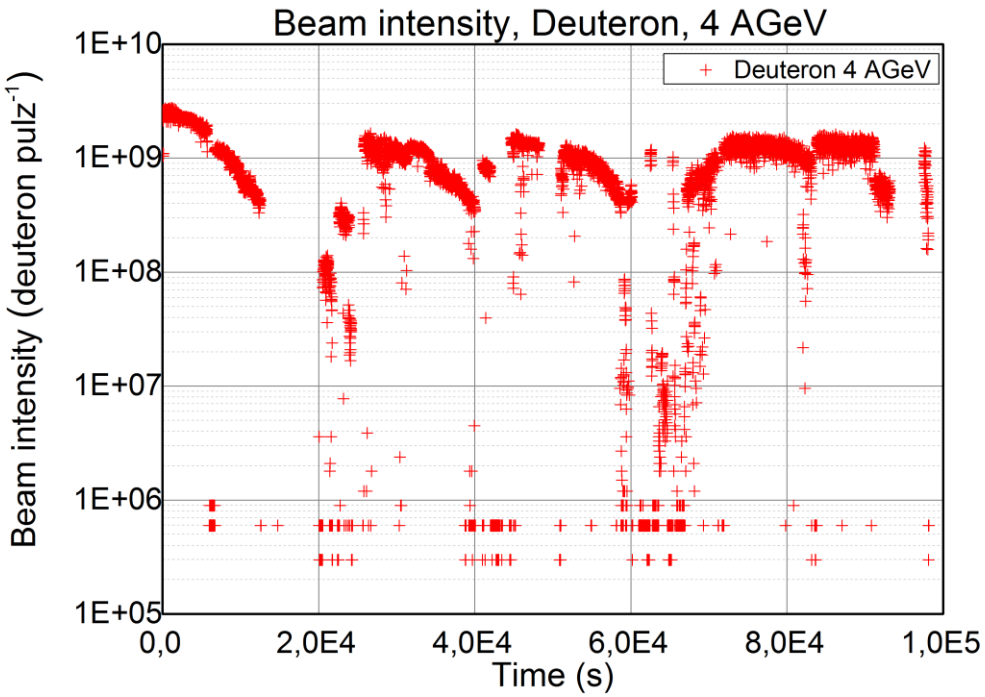
Overview

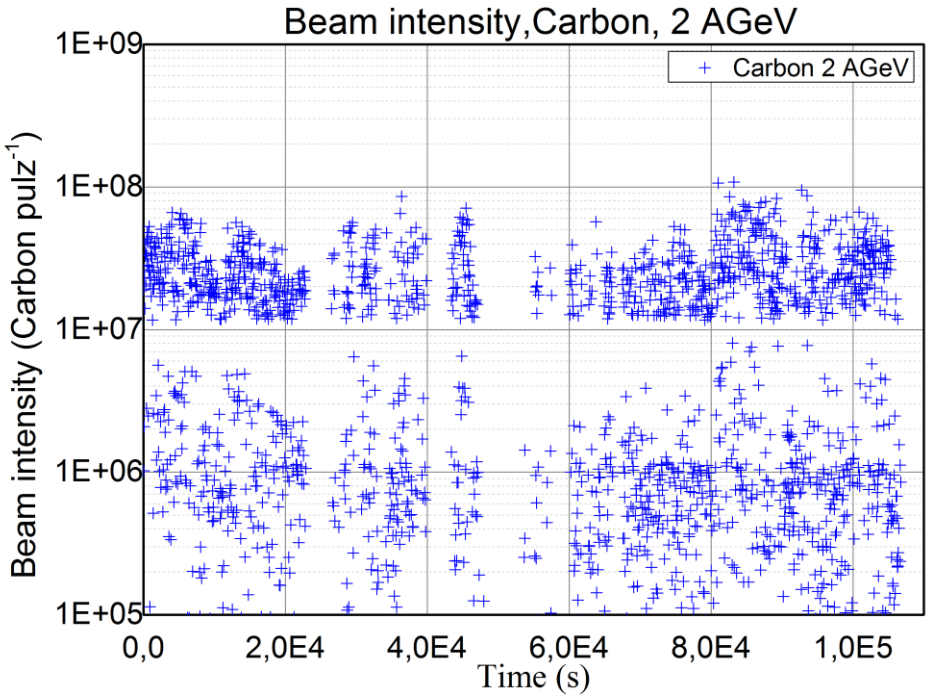
- Samples of ^{59}Co were irradiated in the secondary neutron field of the ***QUINTA*** target generated by the deuteron beam with energy 4 AGeV and carbon beam with energy 2 AGeV.
- The experimental **reaction rates** (R_{exp}) of products in ^{59}Co were obtained with the use of Gamma spectrometry.
- Comparison of **neutron flux** at different positions of different **experiments** with simulations with MCNPX 2.6

Target *QUINTA* setup and positions samples of ^{59}Co

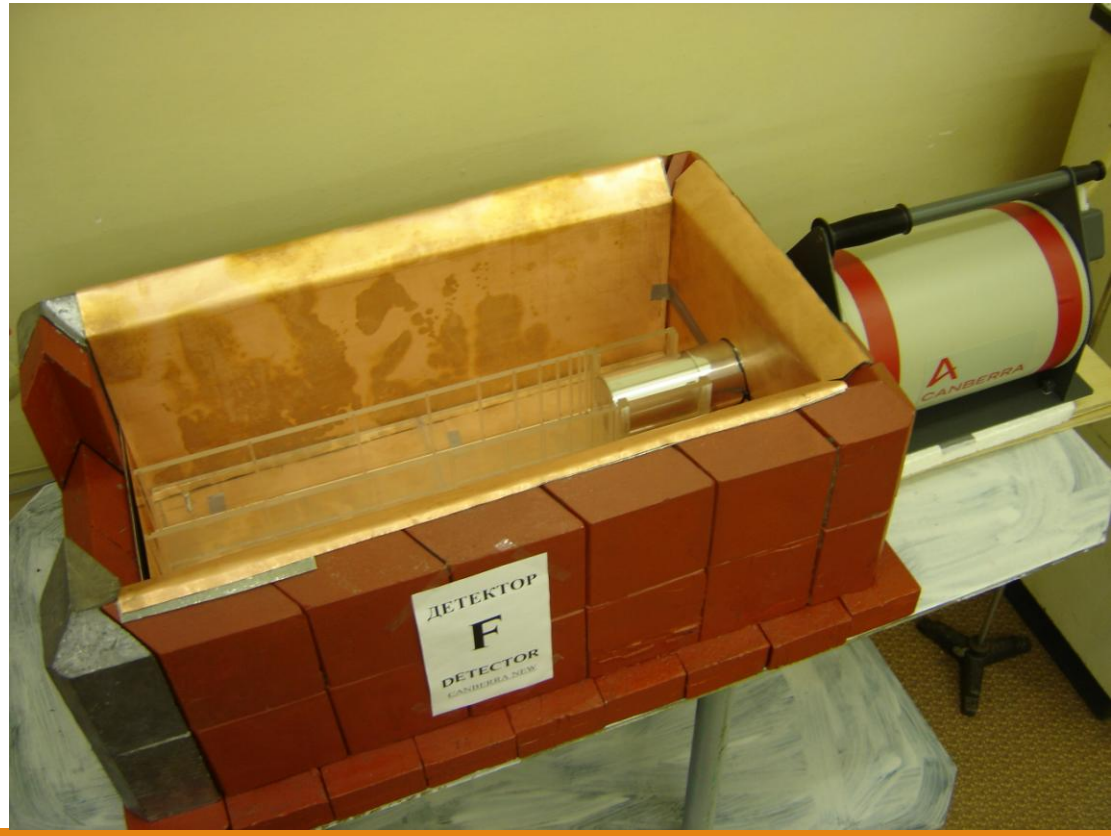


Particles	Energy	Number of particles	Time of irradiation
Deuteron	4 AGeV	$(6.11\pm0.08)\cdot10^{12}$	27 h and 18 min
Carbon	2 AGeV	$(2.14\pm0.15)\cdot10^{11}$	30 h and 18 min

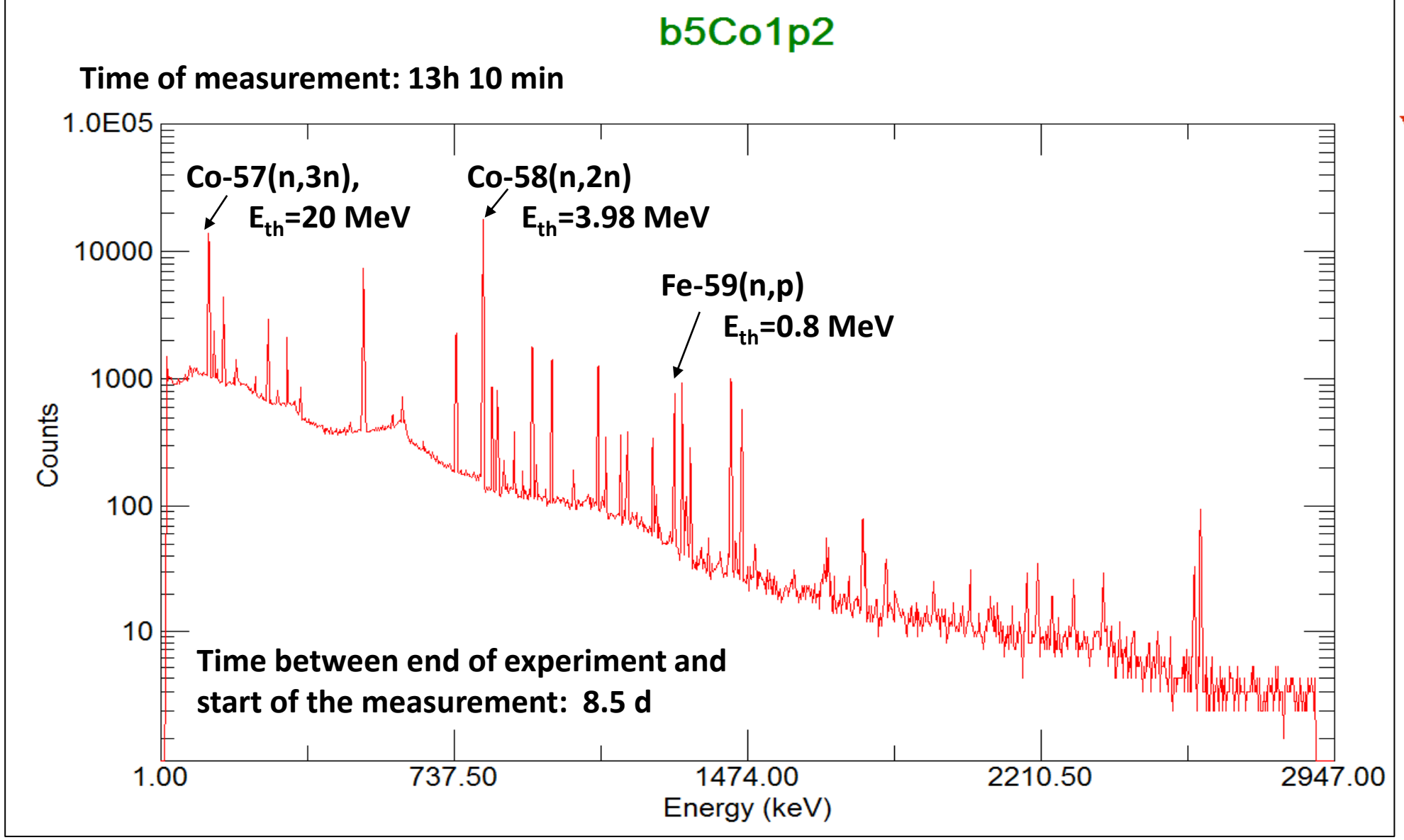


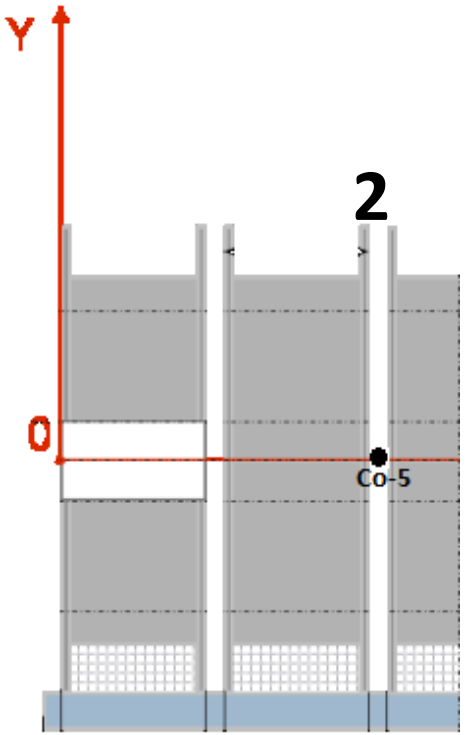


- After irradiation, the experimental samples were transported to the **YaSNAPP** spectroscopy laboratory and measured with the use of high purity germanium semiconductor detectors.



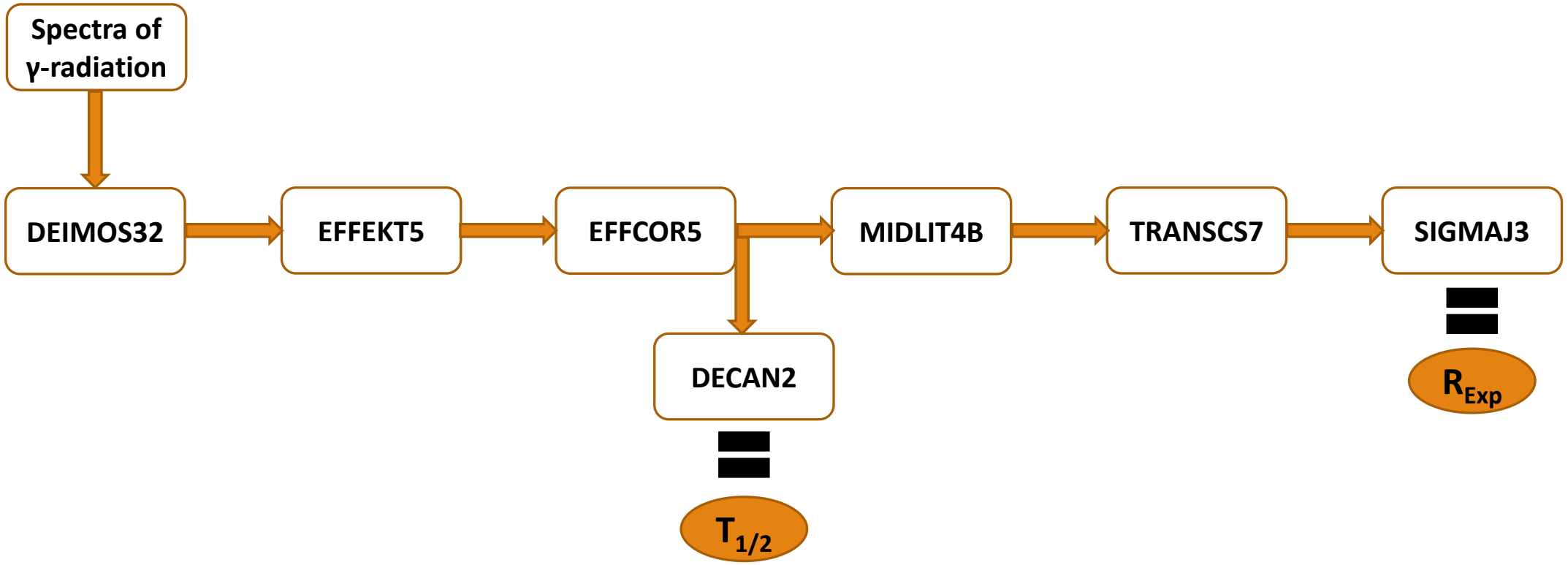
- Detector efficiency: 28-35%



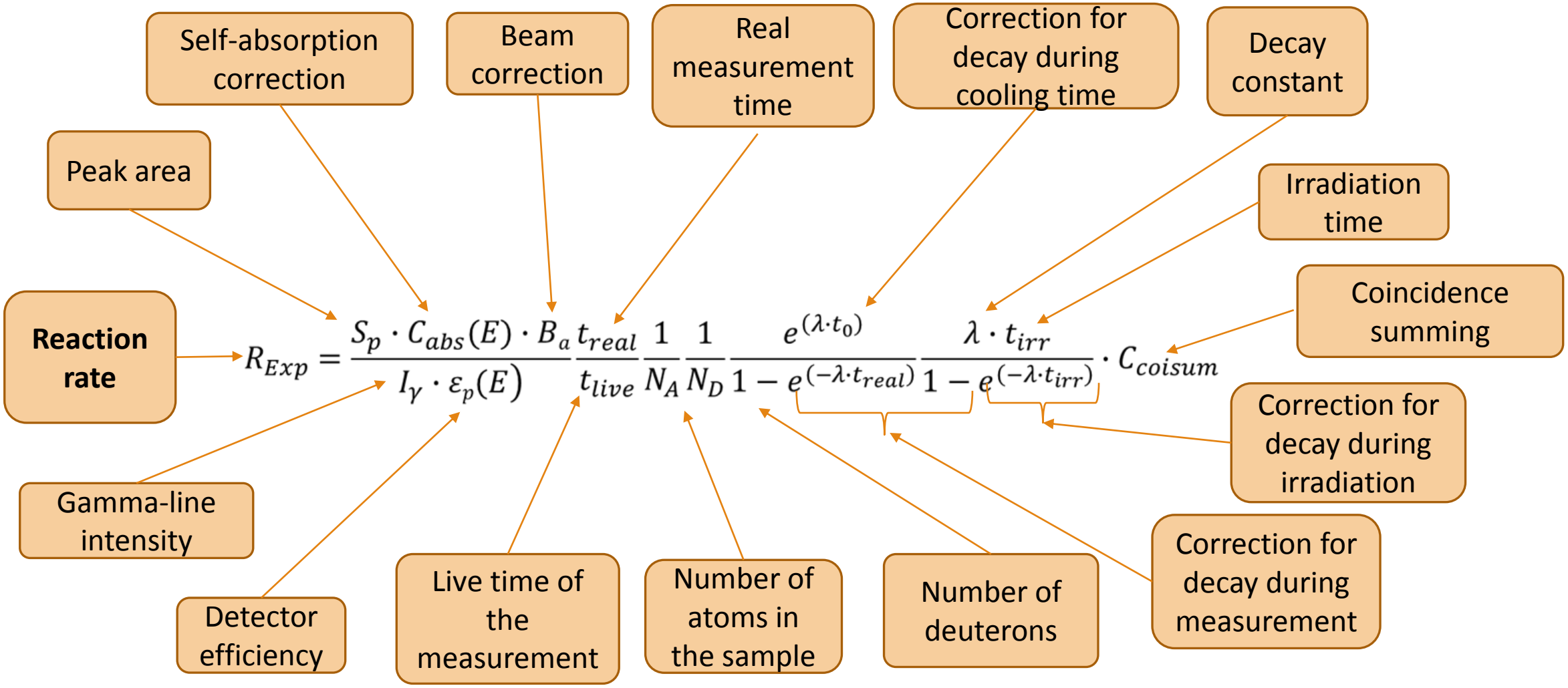


An example of γ-ray spectrum in the sample ^{59}Co.

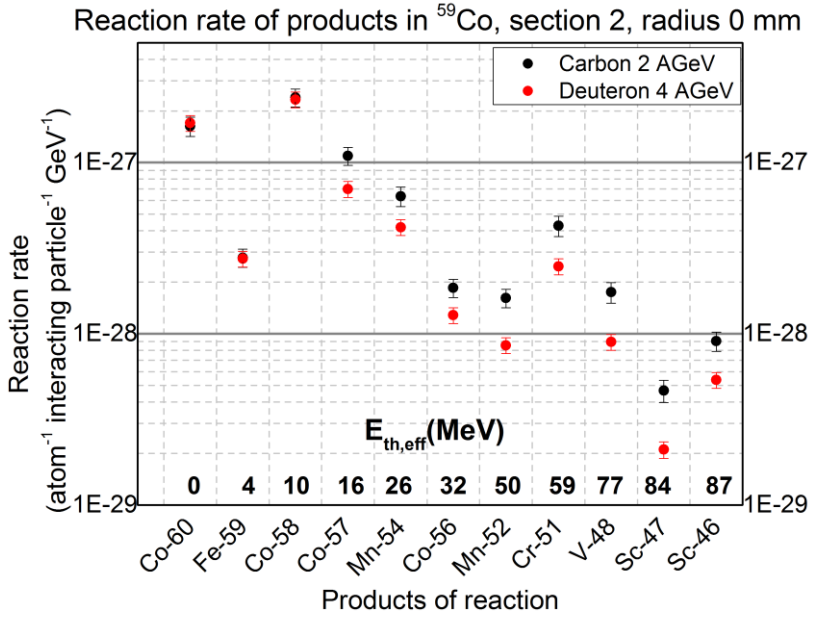
Yasnapp spectrometry software package

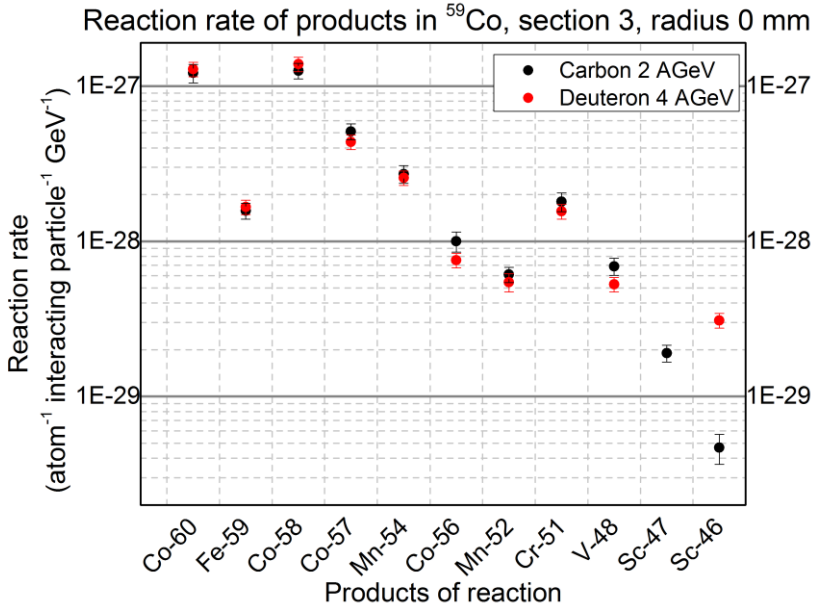


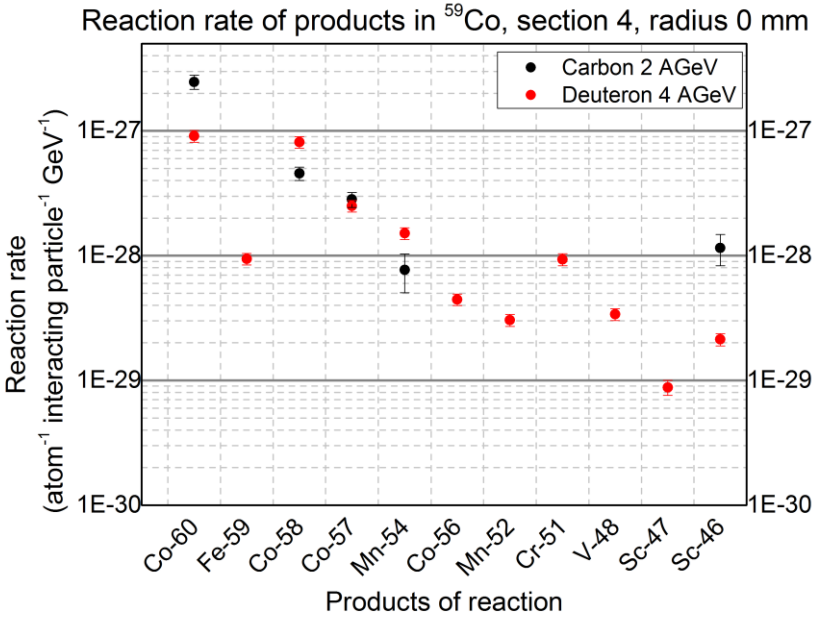
A set of computer codes has been used for the energy calibration, subtraction of background gamma-ray lines, efficiency calibration and determination of experimental half-lives for the identification of gamma-ray lines. Various isotopes are assigned only when energy, half-life and intensity of peaks match with the values available in the literature.

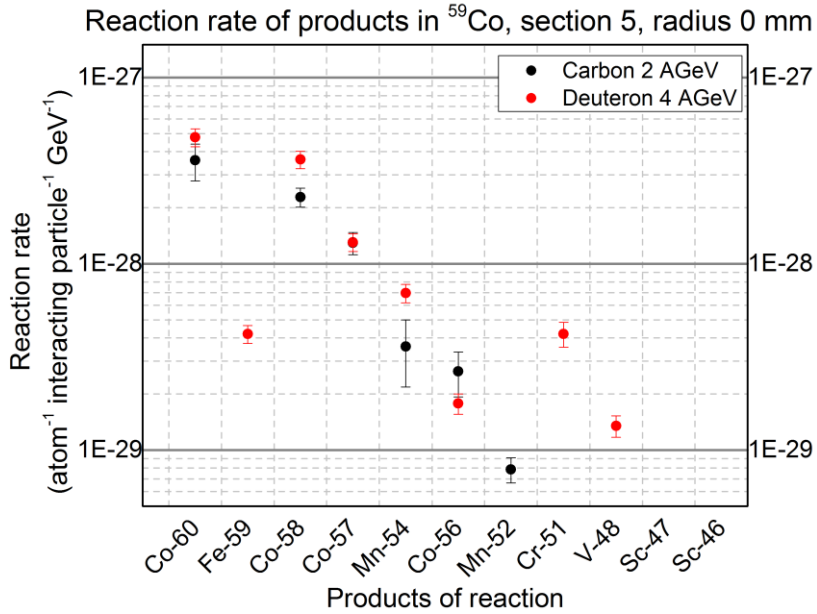


Reaction rate - is defined as the number of produced residual nuclei $Q(A_r, Z_r)$ per one atom in the sample N_t and one incident deuteron per second N_d according to the following equation.

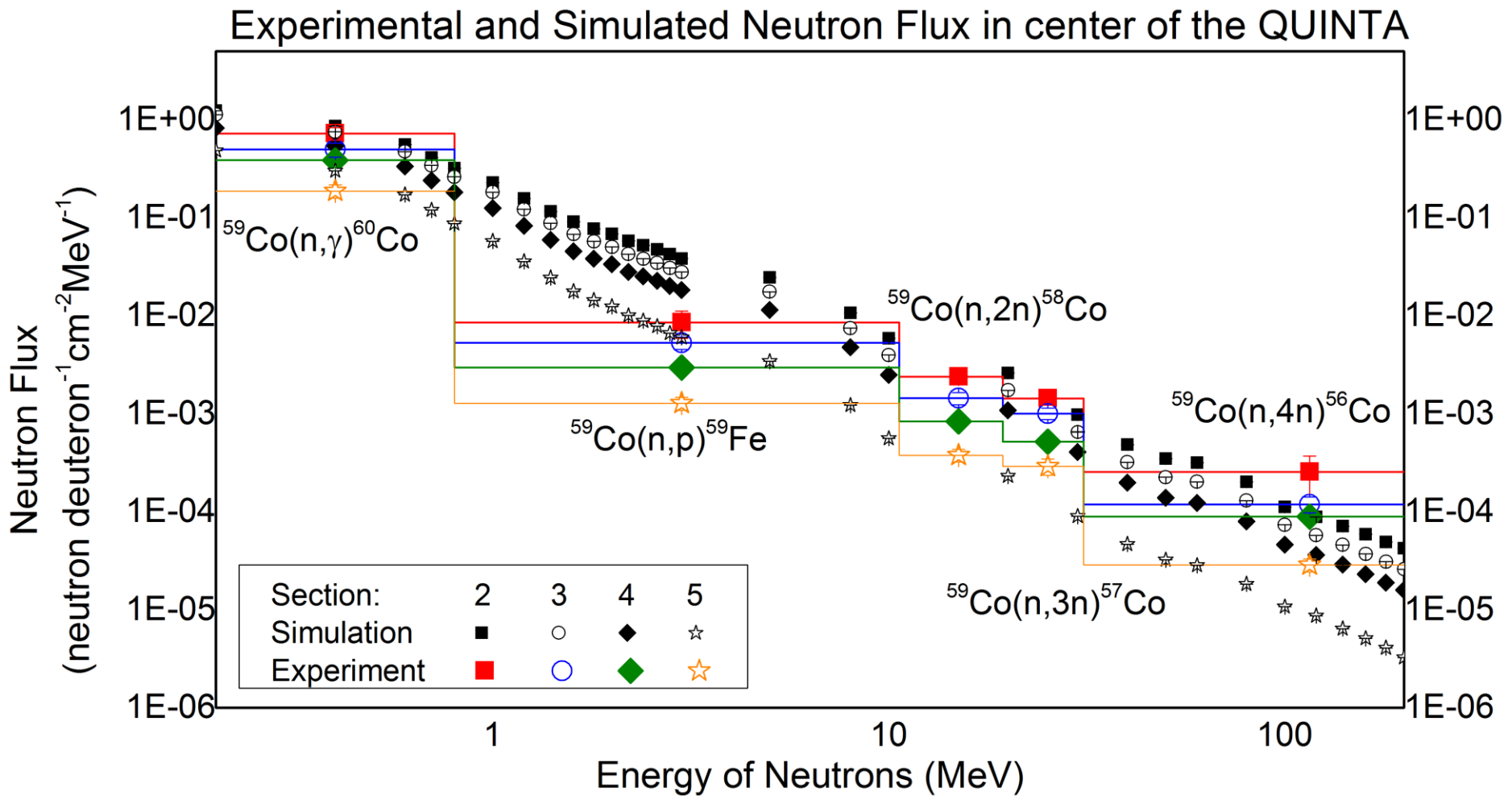

Reaction rate of products in ^{59}Co, section 2, radius 0 mm
Carbon 2 AGeV
Deuteron 4 AGeV
Reaction rate
(atom^{-1} interacting particle^{-1} GeV^{-1})
1E-27
1E-28
1E-29
$E_{th,eff}$(MeV)
0 4 10 16 26 32 50 59 77 84 87
Co-60 Fe-59 Co-58 Co-57 Mn-54 Co-56 Mn-52 Cr-51 V-48 Sc-47 Sc-46
Products of reaction


Reaction rate of products in ^{59}Co, section 3, radius 0 mm
Carbon 2 AGeV
Deuteron 4 AGeV
Reaction rate
(atom^{-1} interacting particle^{-1} GeV^{-1})
1E-27
1E-28
1E-29
Co-60 Fe-59 Co-58 Co-57 Mn-54 Co-56 Mn-52 Cr-51 V-48 Sc-47 Sc-46
Products of reaction


Reaction rate of products in ^{59}Co, section 4, radius 0 mm
Carbon 2 AGeV
Deuteron 4 AGeV
Reaction rate
(atom^{-1} interacting particle^{-1} GeV^{-1})
1E-27
1E-28
1E-29
1E-30
Co-60 Fe-59 Co-58 Co-57 Mn-54 Co-56 Mn-52 Cr-51 V-48 Sc-47 Sc-46
Products of reaction


Reaction rate of products in ^{59}Co, section 5, radius 0 mm
Carbon 2 AGeV
Deuteron 4 AGeV
Reaction rate
(atom^{-1} interacting particle^{-1} GeV^{-1})
1E-27
1E-28
1E-29
Co-60 Fe-59 Co-58 Co-57 Mn-54 Co-56 Mn-52 Cr-51 V-48 Sc-47 Sc-46
Products of reaction

Comparison of Experimental Neutron Flux with Simulation (Deuteron Beam)



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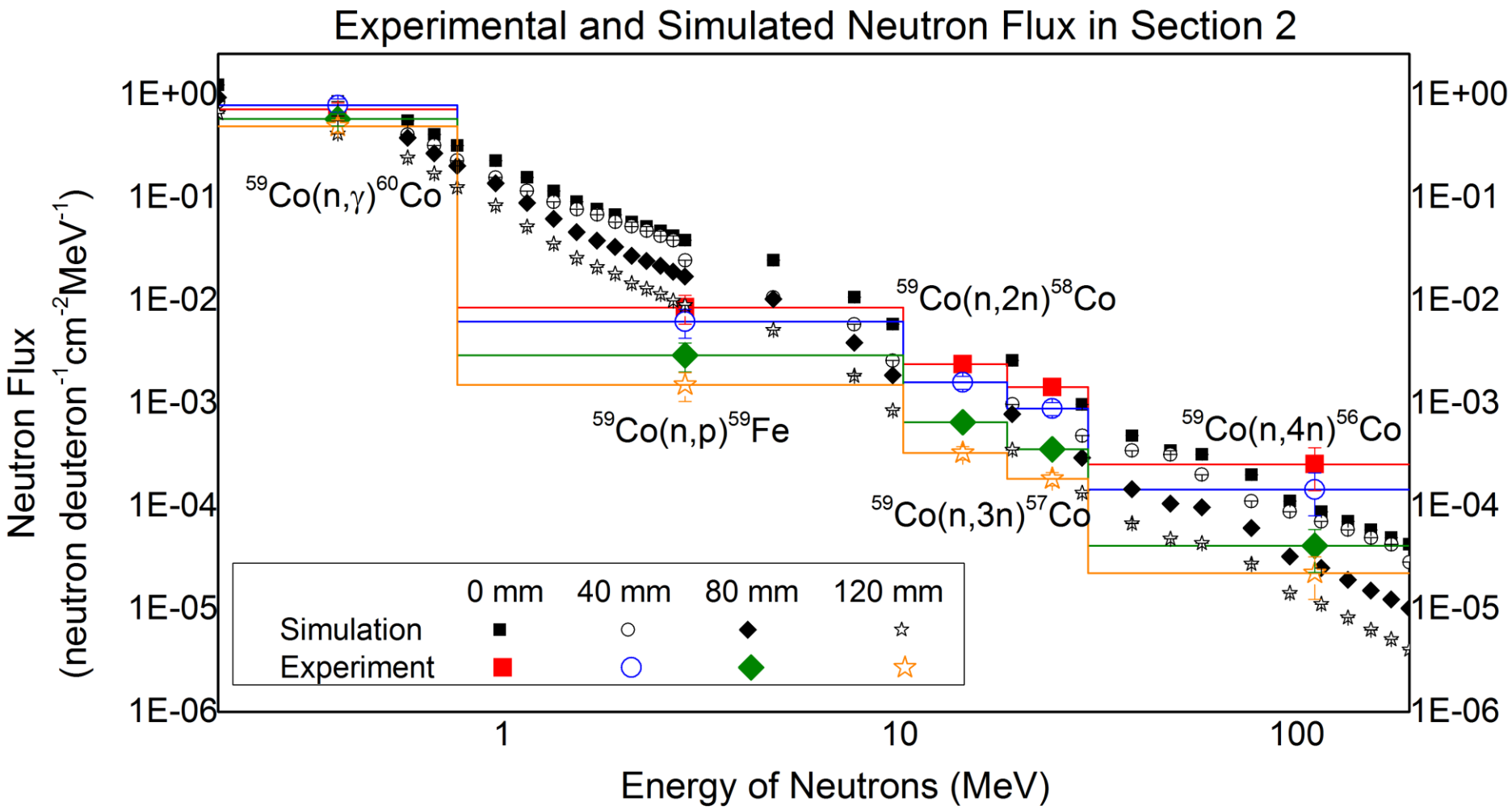
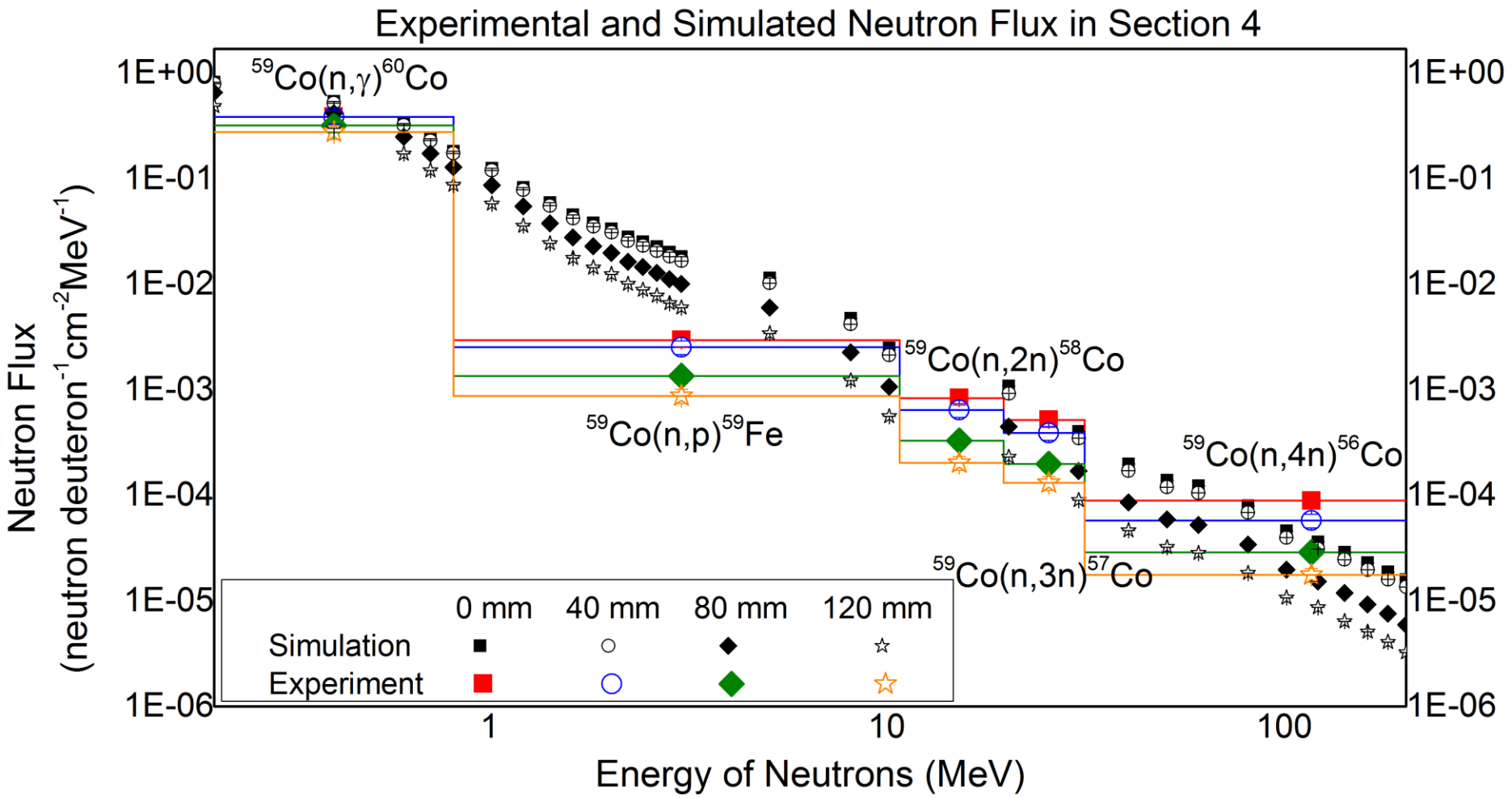
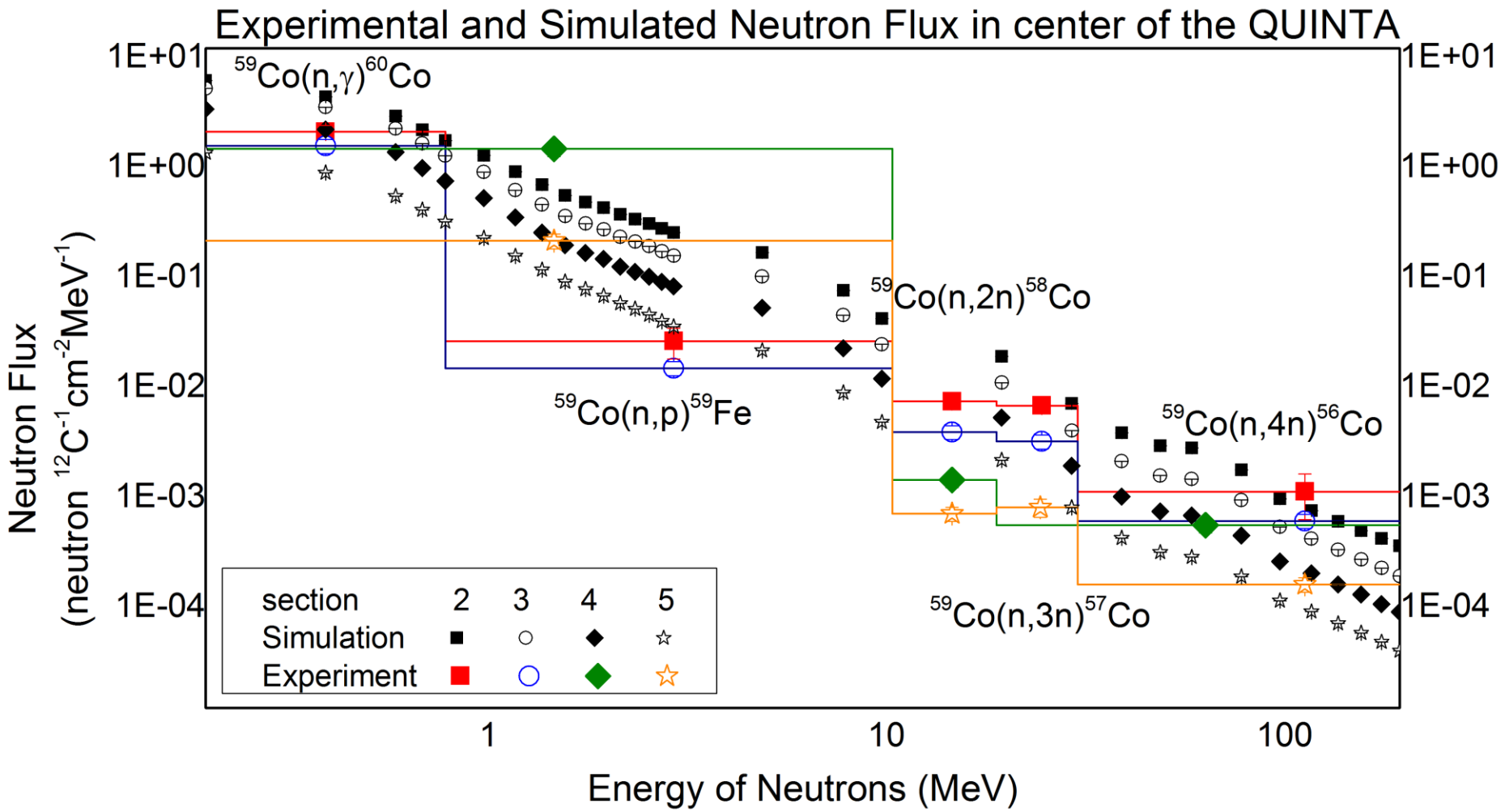


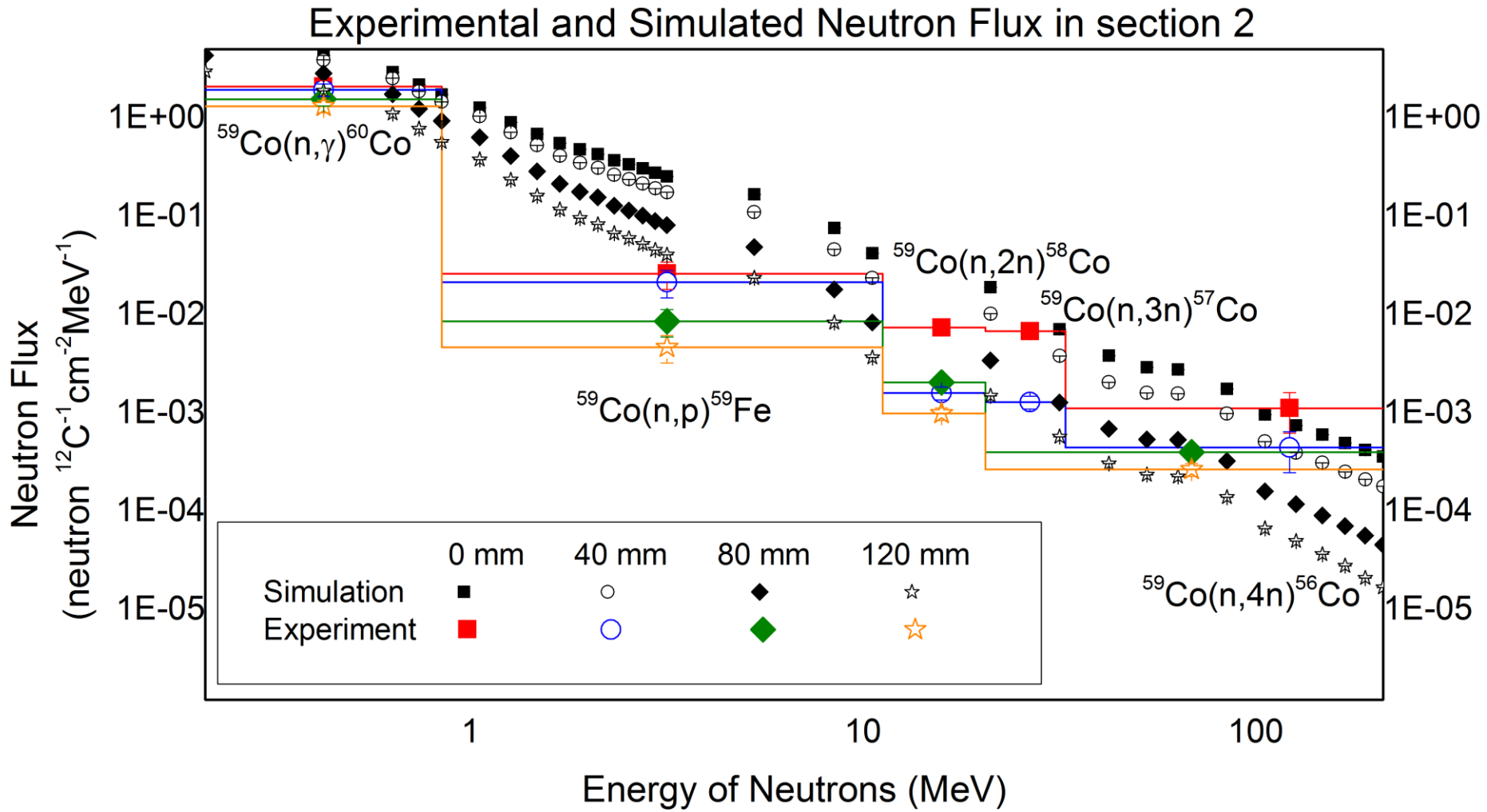
Comparison of Experimental Neutron Flux with Simulation (Deuteron Beam)



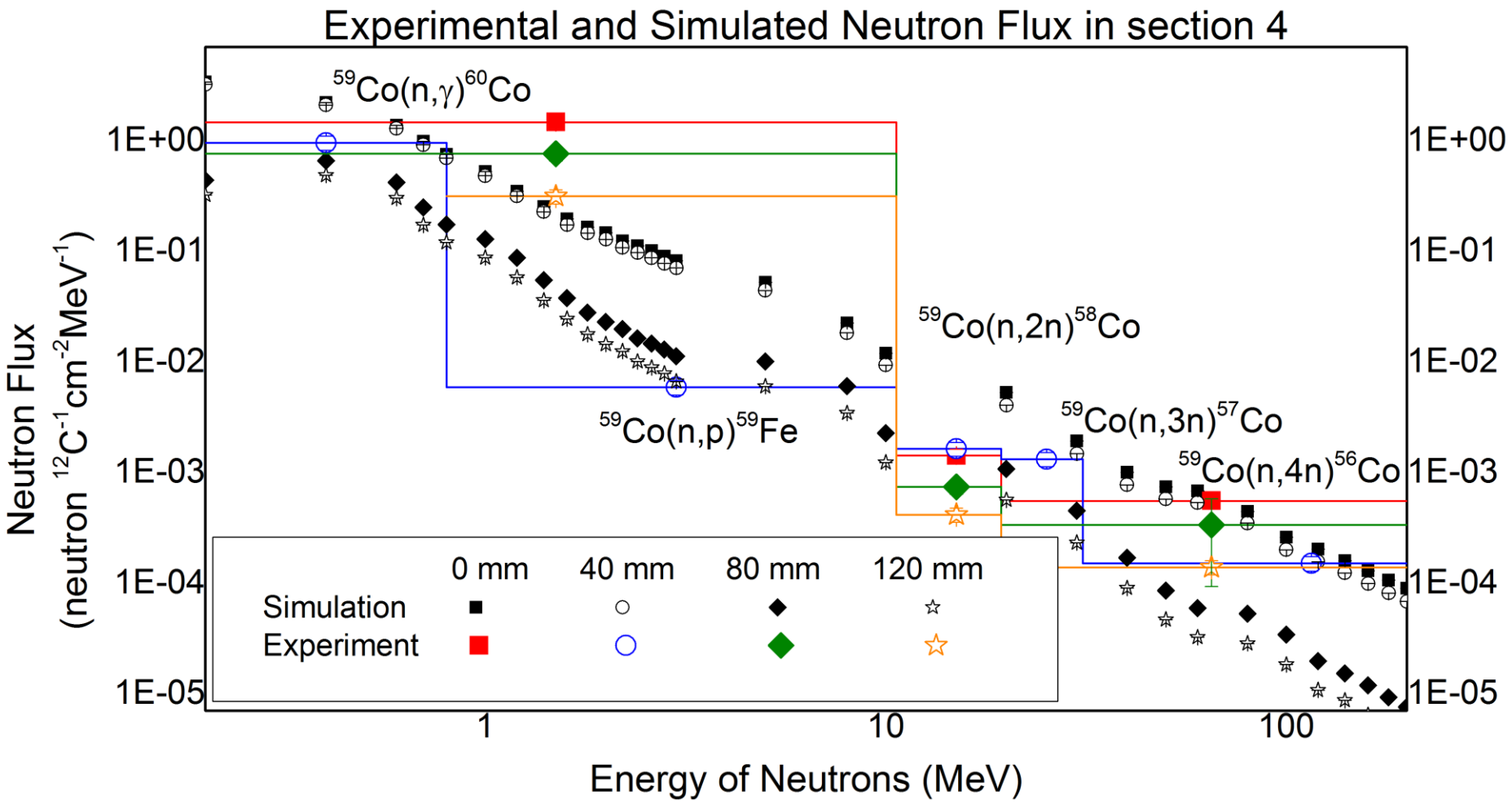
Comparison of Experimental Neutron Flux with Simulation (Carbon Beam)



Comparison of Experimental Neutron Flux with Simulation (Deuteron Beam)



Comparison of Experimental Neutron Flux with Simulation (Deuteron Beam)



Conclusions

- The highest value of experimental reaction rate was at section 2 at position 0 mm. With increasing longitudinal distance(axis Z) and radius(asix Y) reaction rate is decreasing. Agreement between experiments with deuteron and carbon beam has within 2-3 deviations.
- Experimental neutron flux was compared with simulations of MCNPX2.6. Experimental data and simulations had a good agreement with one or two standard deviations for deuteron beam.
- With increasing distance and radius neutron flux is decreasing.

Thank you for your attention