

Experimental Investigation of Radionuclide Production in Uranium Target

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Energy and Transmutation- RAW

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Outline

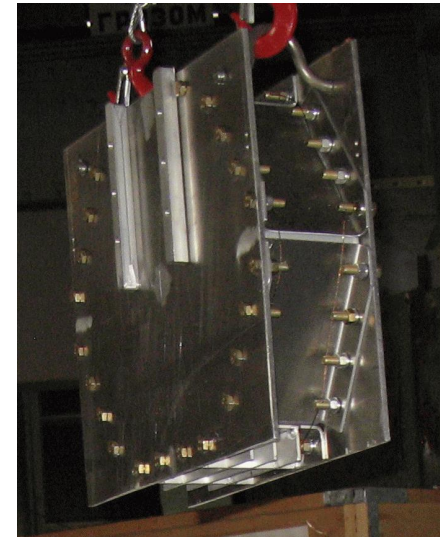
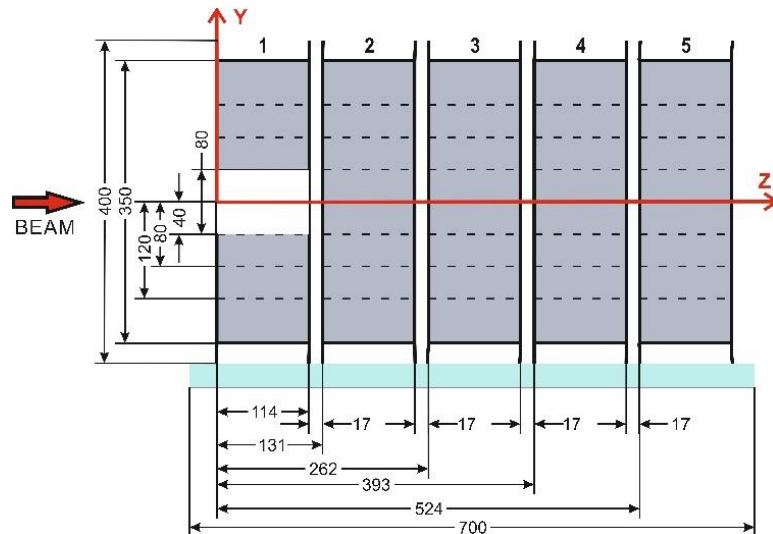
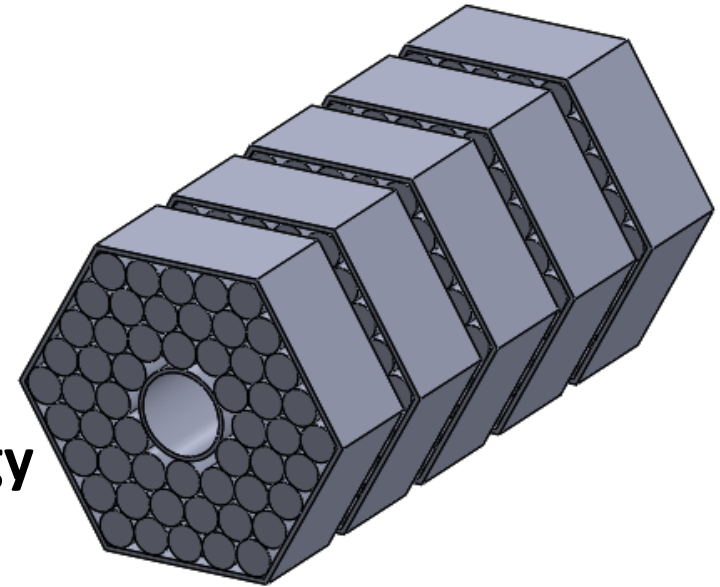
- **Motivation**
- **Experimental part**
- **Determination and comparison of the reaction rates**
- **Conclusion**

Motivation

- Experimental research on transmutation of **spent nuclear fuel**
- Determination of the neutron spectra without **initial guess** of neutron spectrum
- Validation of nuclear data important for **ADS** research

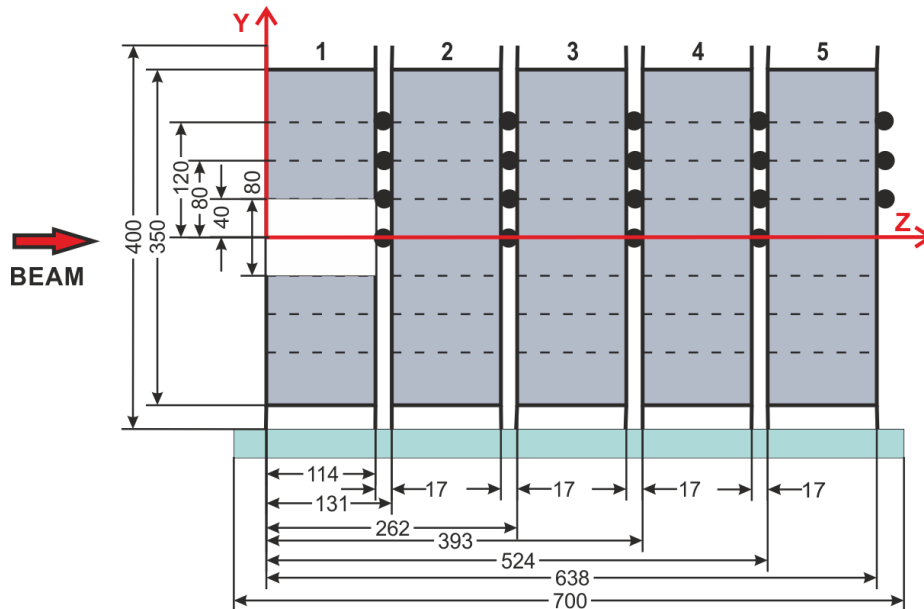
QUINTA

- Natural metallic uranium - **512 kg**
- $350 \times 350 \times 700 \text{ mm}^3$
- 5 sections
- Surrounded – lead bricks 100 mm
- Irradiated at the **Phasotron** (Synchrocyclotron-protons with energy **660 MeV**) accelerator



Experimental part

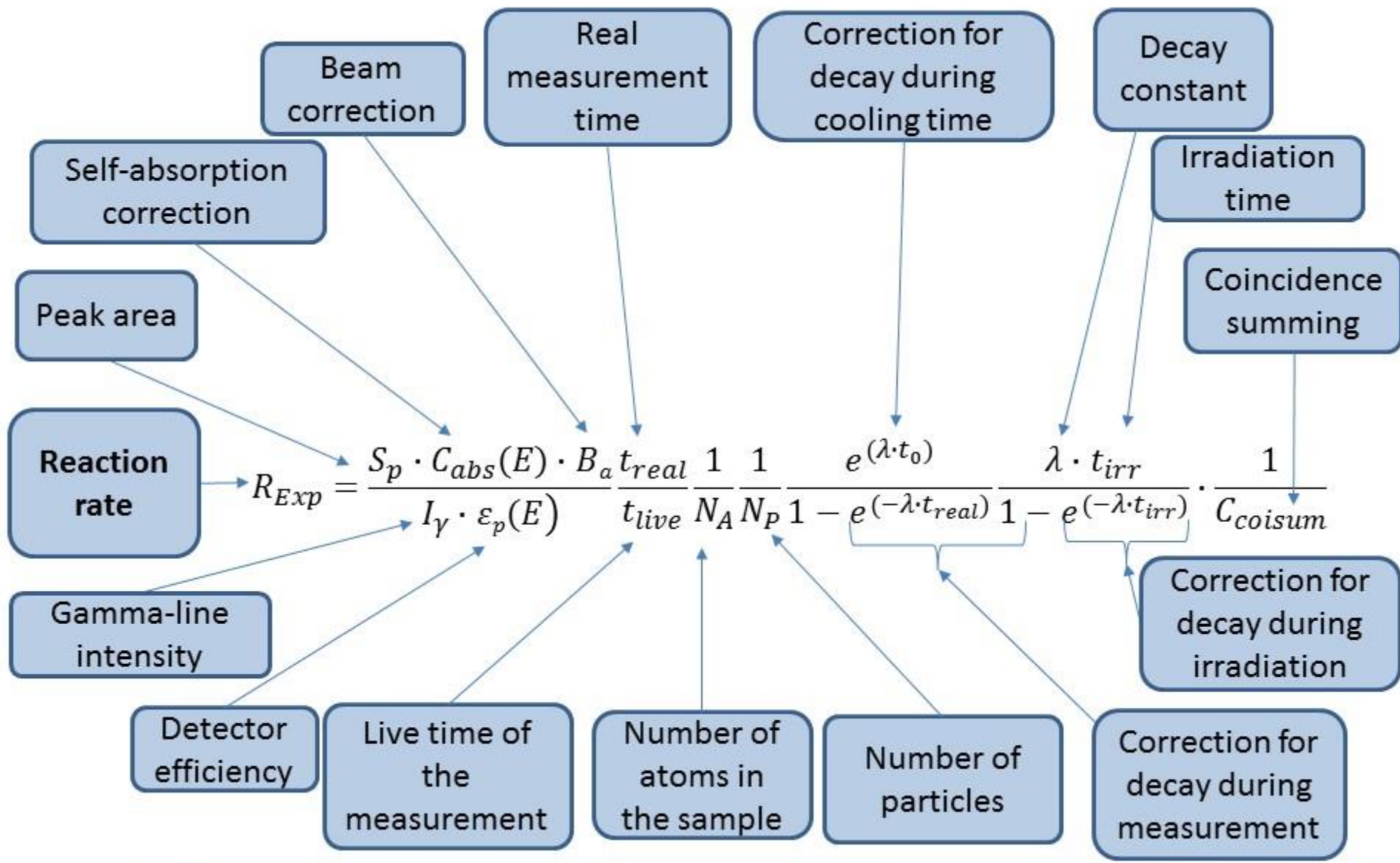
- Particle: **Proton (generate secondary neutrons)**
- Energy: **660 MeV**
- Time of irradiation: **4h and 58 min; 6h**
- Number of particles: **$1.43(15) \cdot 10^{15}$; $4.16(43) \cdot 10^{15}$**
- Threshold activation detectors: **Co**



Steps of experiments

- Activation measurement technique
- Gamma-ray spectroscopy with the use of planar and coaxial (P- and N-type HPGe) detectors Canberra and ORTEC of up to **35 %** relative efficiency
- Calibrated with standard gamma-ray point sources from **5 keV** up to **3 MeV**
- Efficiency compared with **MC simulation**

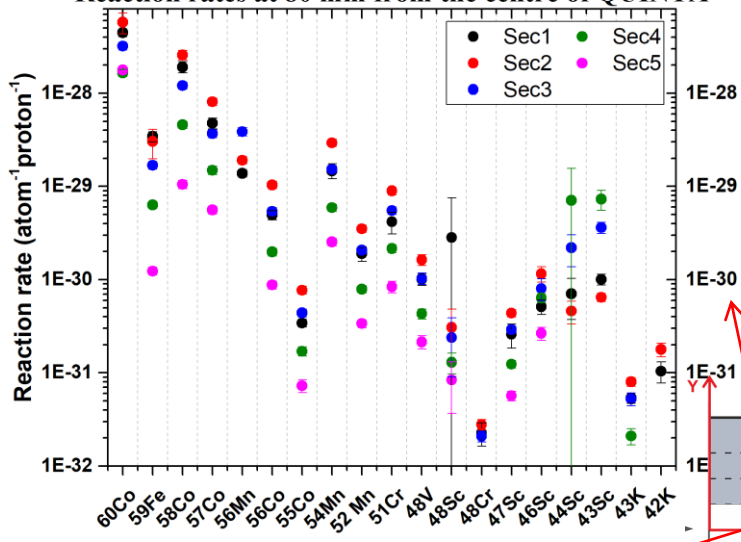




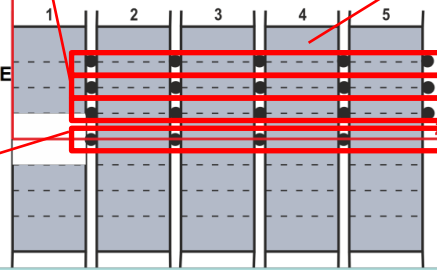
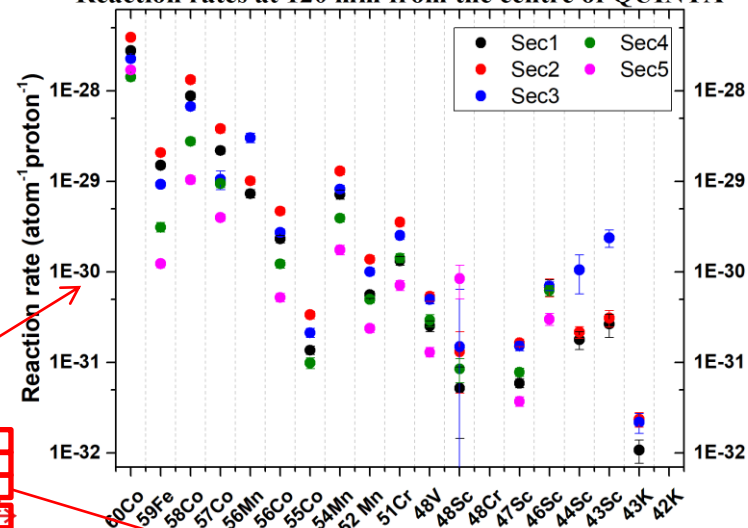
Reaction rate - is defined as the number of produced residual nuclei $Q(A_r, Z_r)$ per one atom in the sample N_A and one incident particle N_P .

Experimental Results

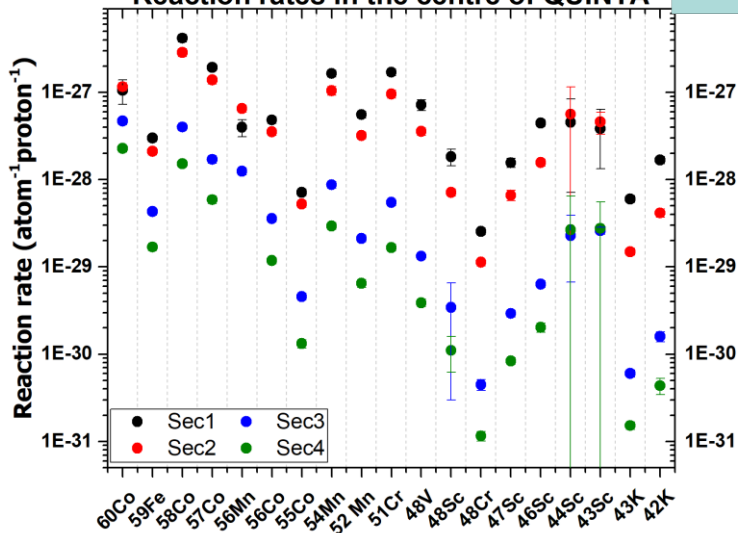
Reaction rates at 80 mm from the centre of QUINTA



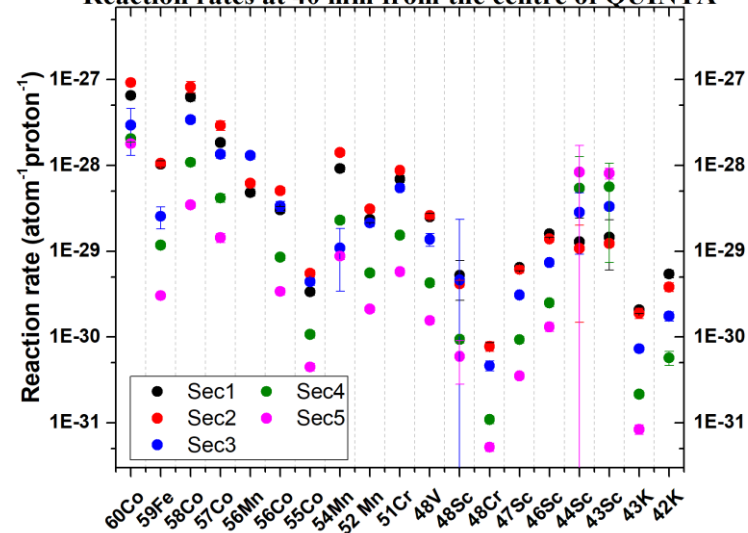
Reaction rates at 120 mm from the centre of QUINTA



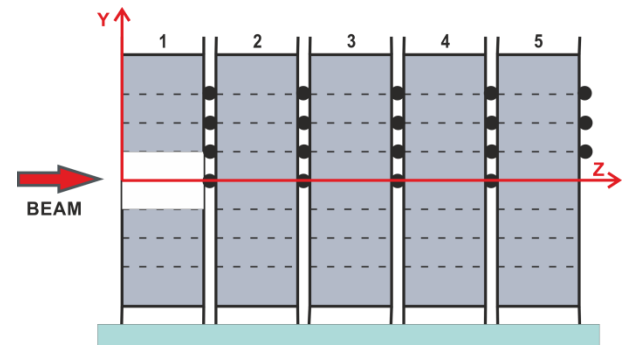
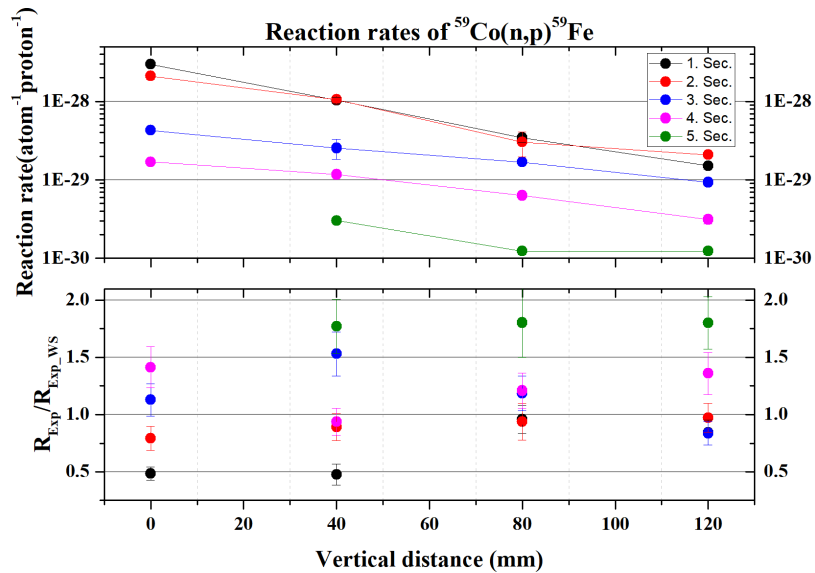
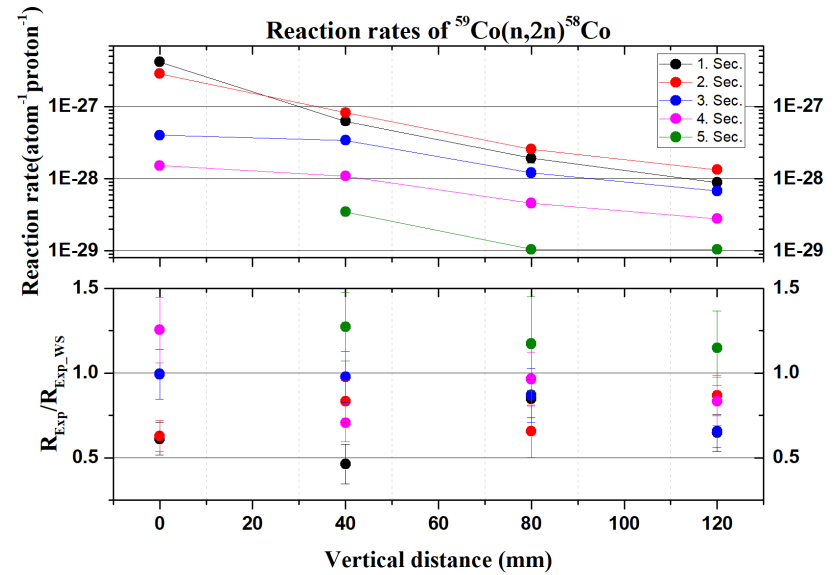
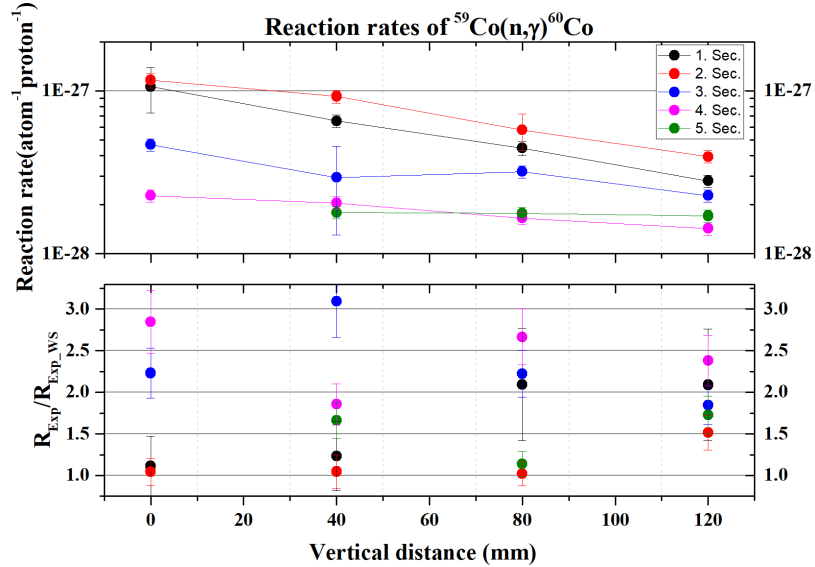
Reaction rates in the centre of QUINTA



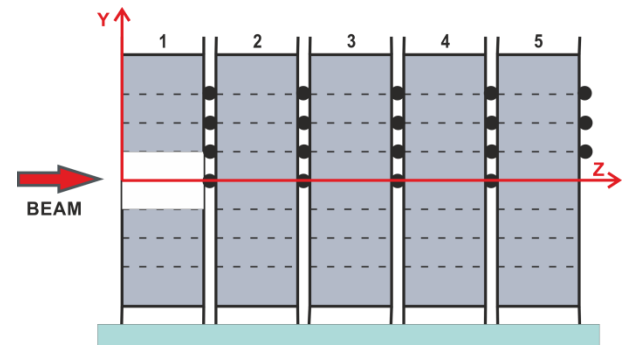
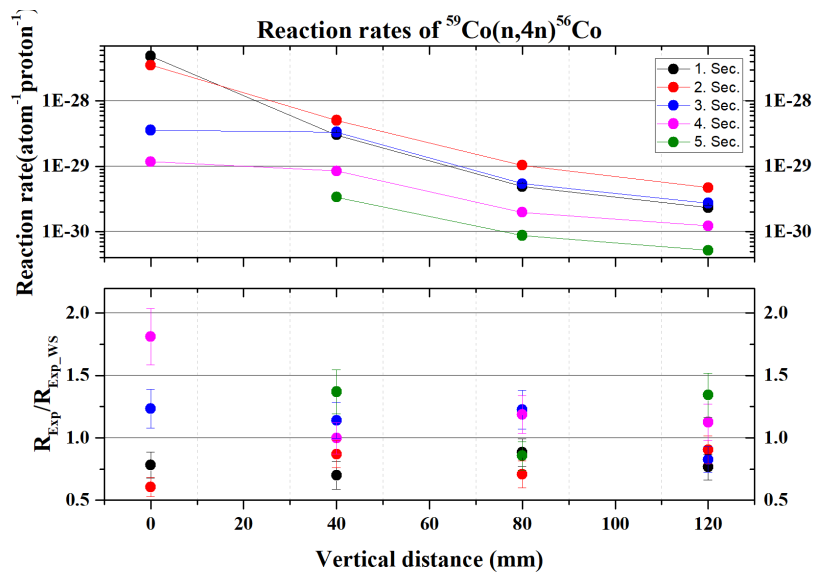
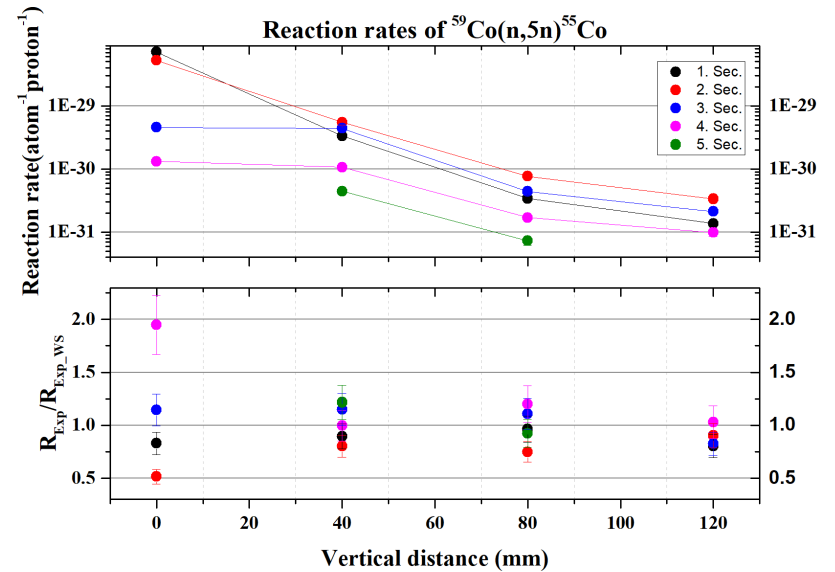
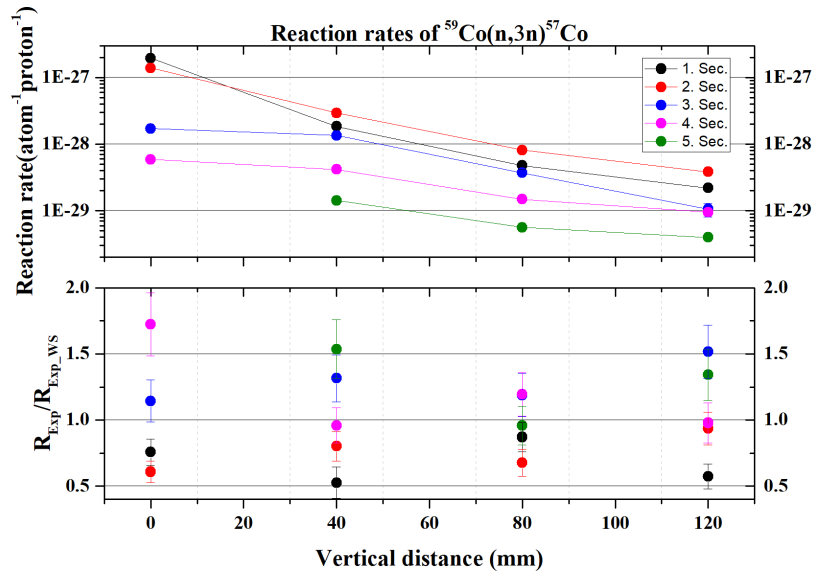
Reaction rates at 40 mm from the centre of QUINTA



Experimental Results



Experimental Results



Conclusion

- Experimental determination of the reaction rates in Co with and without lead shielding
- Highest reaction rates behind section 2
- Highest span of the ratios in the centre of *QUINTA*
- Lowest span of ratios at the position 120 mm
- Highest mean ratio for $^{59}\text{Co}(n,\gamma)^{60}\text{Co}$ at position 120 mm

Future development:

- Spallation target made of **depleted uranium** (21 t)

Thank you for your attention

