



Variance reduction application for activation of construction materials estimation

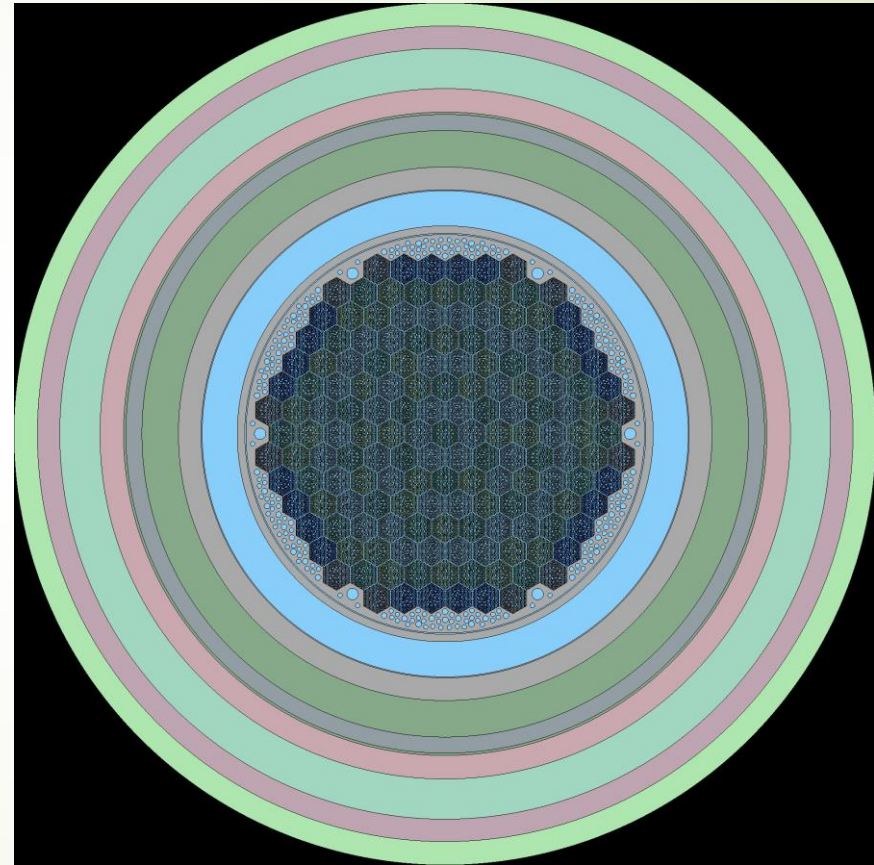
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Neutron flux and estimation of activation of construction materials

- ▶ Activation is the function with flux as derivative:
$$A(t) = N\sigma\phi(1 - e^{-\lambda t}),$$
where A is activation, N – quantity of reacted nuclei,
 σ – reaction cross-section, ϕ – neutron flux, λ – decay constant.
- ▶ Thus one can estimate activation by estimation of depletion and material activation. For nuclear power plants(NPP) this is the one of the most important estimations for nuclear safety measures.
- ▶ There are few way to do so, such as use of special engineering codes or Monte Carlo approach. Each one has its ups and downs. While they provide good results engineer codes can be applied to a very small range of situation. Monte Carlo approach give more flexibility at cost of time of calculation.

Model

- In this paper showed how to estimate neutron flux near concrete of the VVER-1200 type NPP.



➤ Pic 1. NPP model plot OXY

Neutron flux and estimation of activation of construction materials(cont.)

- ▶ Main problem for estimation of activation for NPP with Monte Carlo is the size of NPP. Inverse square law and material moderation and absorption of neutrons make it quite difficult to estimate flux at long distances from center of the core of a NPP. Variance reductions methods such as weight windows and its derivatives proved to be helpful for such cases. But there are problems with weight windows estimators. It estimates weight windows parameters only for cells that have neutron history, i.e. if there were no neutron at all then weight windows parameters are zeroes. So in order to obtain flux with use method of estimation of weight windows showed in previous paper¹ we obtained new weight windows and flux.

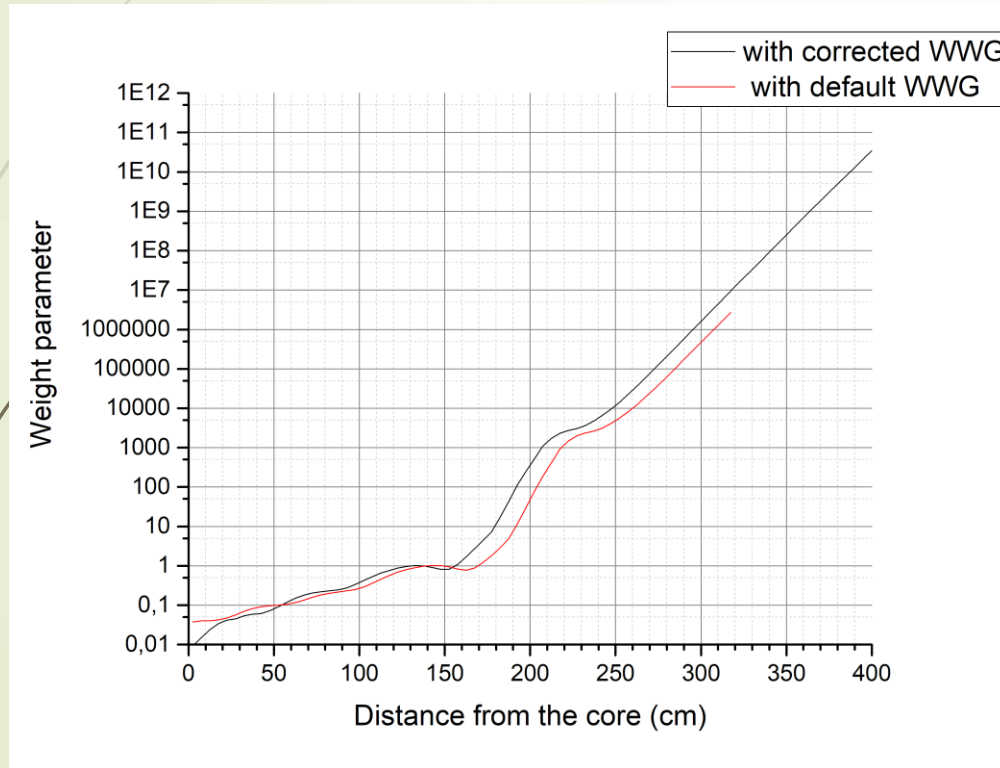
Weight windows estimation

- $\Phi_V = \frac{1}{V} \int dE \int dt \int dV \int W(\vec{r}, \hat{\Omega}, E, t) \psi(\vec{r}, \hat{\Omega}, E, t) d\Omega;$
- $\frac{dN}{dx} = (\sigma - \sigma_s f)N(x) - \sigma_s rL(x);$
- $\frac{dL}{dx} = -(\sigma - \sigma_s f)L(x) + rN(x).$
- $I = \frac{\Psi_1}{\Psi_2}$

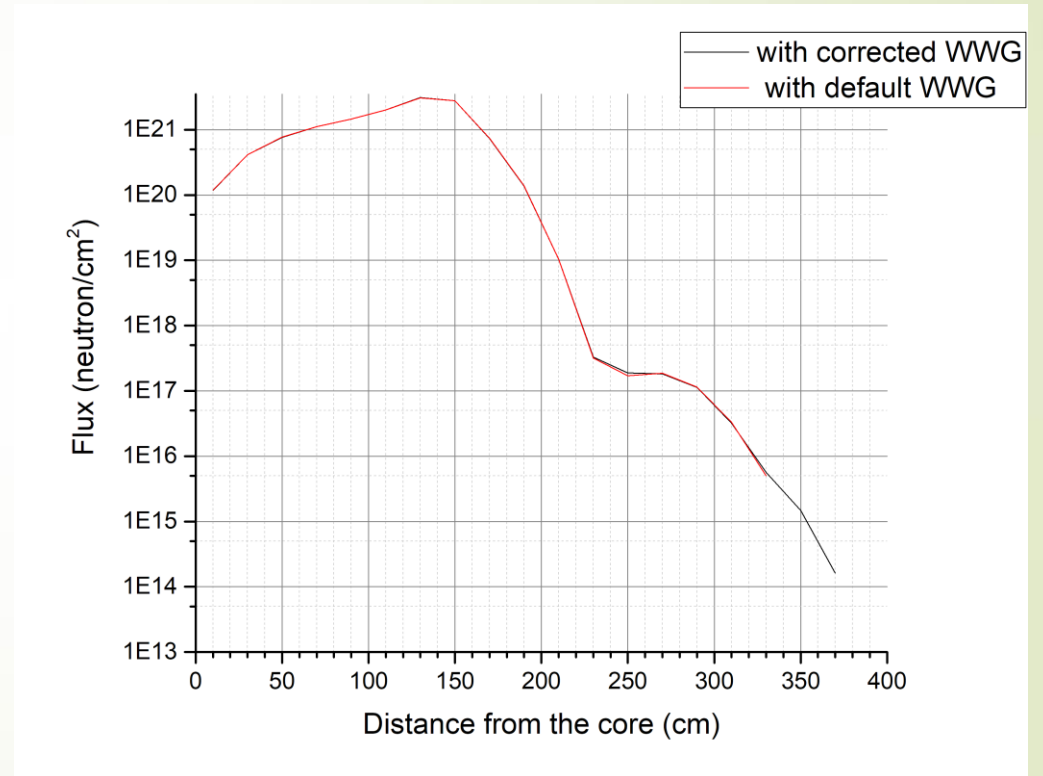
where Ψ_1 и Ψ_2 – flux at entrance and exit of a cell



Weight windows functions and flux



► Pic.3 Weight windows by distance



► Pic 3. NPP model plot OXY

Conclusion

- ▶ Weight windows cannot be used without understanding ways of estimation of parameters for this method. Here showed the way to obtain flux with small adjusting to weight windows while without correction base weight windows parameters are zero and one cannot obtain flux with this variance reduction method even if he increase calculation time. Though one still can obtain correct flux by increasing calculation time but in some cases in could be counter effective because of great amount of time for this.



Thank you!