

Method validation for using the best fitting parameters in simulating the source term of radioxenon generated by neutron activation



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INTRODUCTION

- neutron activation as a source of radioxenon emission
- contributing to the atmospheric radioxenon background
- different isotopic ratios than radioxenon from fission

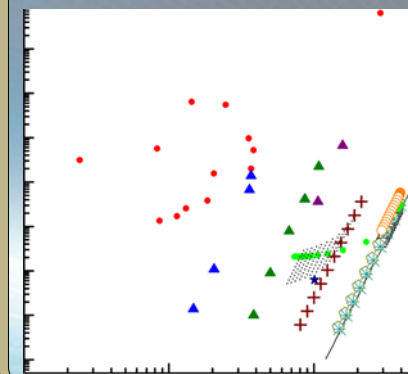
METHODS/DATA

- Simulation of Tehran research reactor with MCNPX2.6 to obtain weighted cross section
- Calculating the isotopic ratios by using MATLAB and cross sections from different references

START

RESULTS

4-isotope plot



CONCLUSION

- Neutron cross-sections were identified for which Matlab simulations reproduce well the Vienna TRIGA observation data.

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- Recent studies emphasize neutron activation as a source of radioxenon emission which needs to be considered as contributing to the atmospheric radioxenon background. Since activation products have different isotopic ratios than radioxenon from fission taking activation into consideration impacts on the determination of the origin of radioxenon detected by the International Monitoring System (IMS).
- The parameters that need to be used for simulations of the activation source include the neutron energy spectrum, neutron flux, the activation cross section, irradiation time and retention time. Any difference in these parameters changes the resulting isotopic ratios.
- In this presentation all these parameters are investigated and the most suitable of them are introduced for the next studies.



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Studying the parameters that may influence the simulation of isotopic ratios resulting from neutron activation:

- neutron energy spectrum,
- neutron flux,
- the activation cross section,
- irradiation time and
- retention time.



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- Using a histogram bar chart for comparing $Xe(n,\gamma)$ cross sections from different references
- Simulation of Tehran research reactor by MCNPX2.6 to obtain weighted cross section for radioxenon produced via neutron activation
- Calculating the isotopic ratios by solving the Bateman equation in MATLAB by using $Xe(n,\gamma)$ cross sections from different references
- Calculating the isotopic ratios with different irradiation times
- Using the 4-isotope plot for comparing the isotopic ratios from observations and simulations using different references and own simulations using ORIGIN and MATLAB



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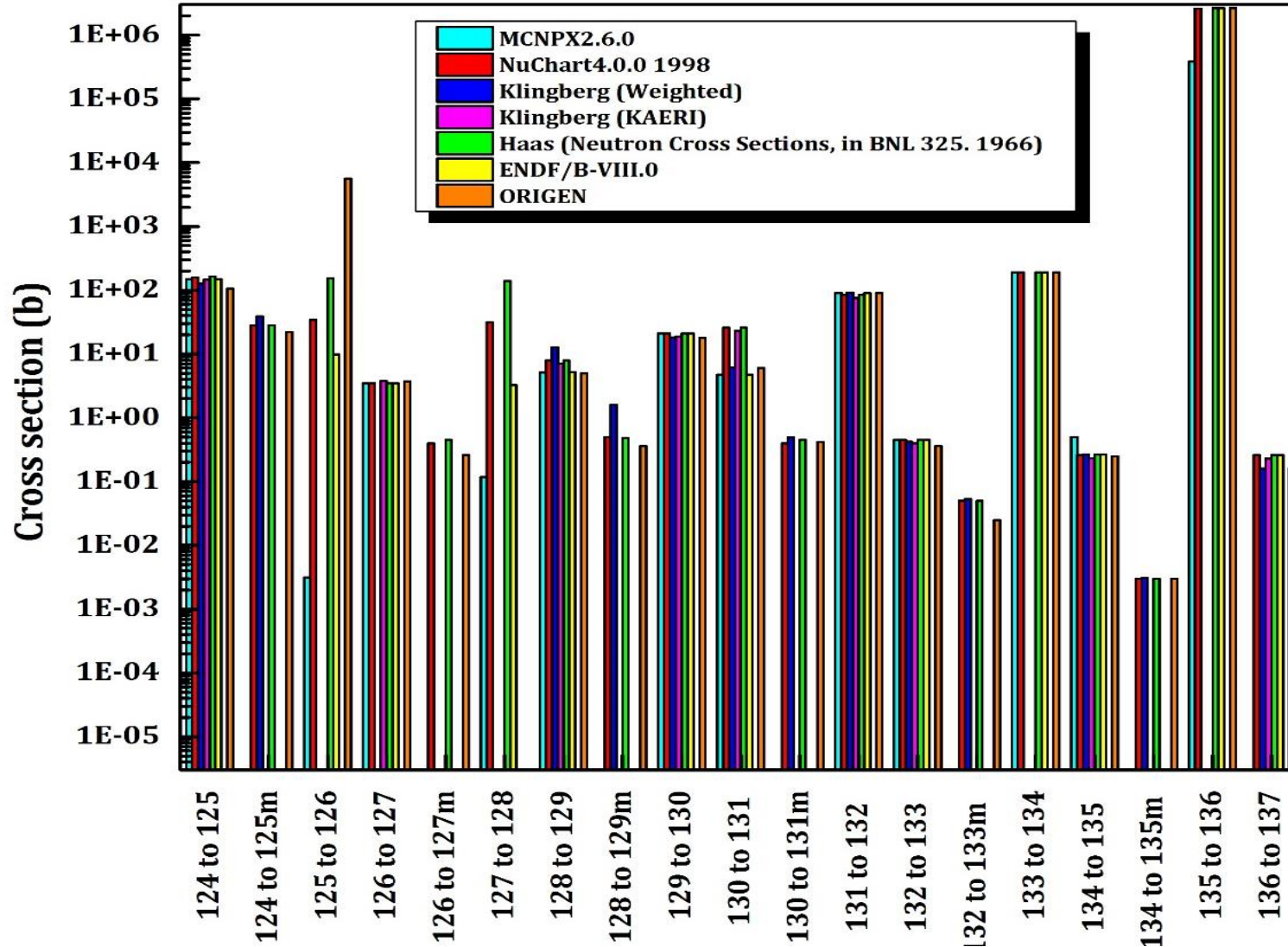


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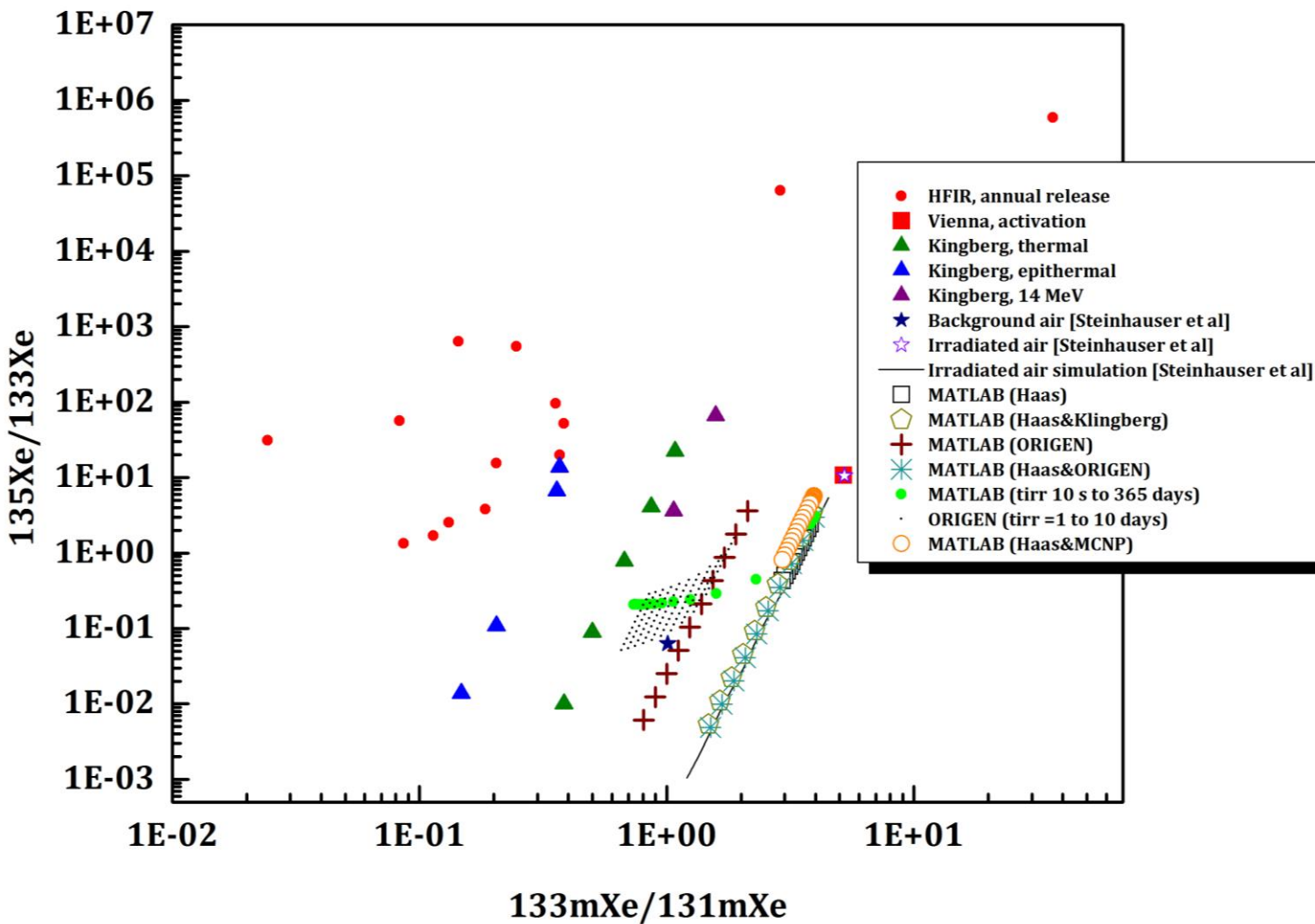
Comparison of
 $Xe(n,\gamma)$ cross
 sections from
 different
 references



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4-isotope plot for comparing the isotopic ratios from observations and simulations using different references and own simulations using ORIGEN and MATLAB.

For the MATLAB simulations (orange circles) we use weighted cross-sections generated with MCNP simulation of the Teheran research reactor. These cross-sections are reflecting the neutron energy spectrum and weighted by the neutron flux. They do not include any data for neutron activation of metastable isotopes. For these, the data from Haas (2008) are used instead.

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1. For most radioxenon neutron activation reactions, the cross-sections of different sources compare well, but for some they are differing by more than one order of magnitude. Therefore, we are validating MATLAB simulations with different cross-sections against measured radioxenon isotopic activity ratios. These measured data are resulting from neutron activation of stable radioxenon at the Vienna TRIGA reactor as reported by Steinhauser et al. (2013).

- A. Using the neutron cross-sections of ORIGEN doesn't reproduce the Vienna TRIGA data.
- B. Using the thermal neutron energy cross-sections of BNL (1966) as done by Haas (2008) reproduces well the Vienna TRIGA data, irrespective of which combination with other cross-section data we use. Most realistic are the weighted cross-sections generated with MCNP and, therefore, these are recommended to use.

2. The reported annual releases of the HFIR can neither be reproduced with thermal neutron energy cross-sections nor with weighted ones. The best match found from the literature is with epithermal neutrons according to Klingberg (2016).

3. Varying the irradiation time from 10 seconds to 365 days causes the isotopic ratios to bend away from the decay curve towards lower meta-stable ratios. This implies, longer retention times result in lower meta-stable ratios.



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