Fuel and Moderator Temperature Feedback of MOX Fuel for DARWIN Reactor Core

Anže Mihelčič[1,2], Dušan Čalič[1], Tanja Goričanec[1,2] and Luka Snoj[1,2]

[1] Reactor Physics Department, Jožef Stefan Institute, Slovenia

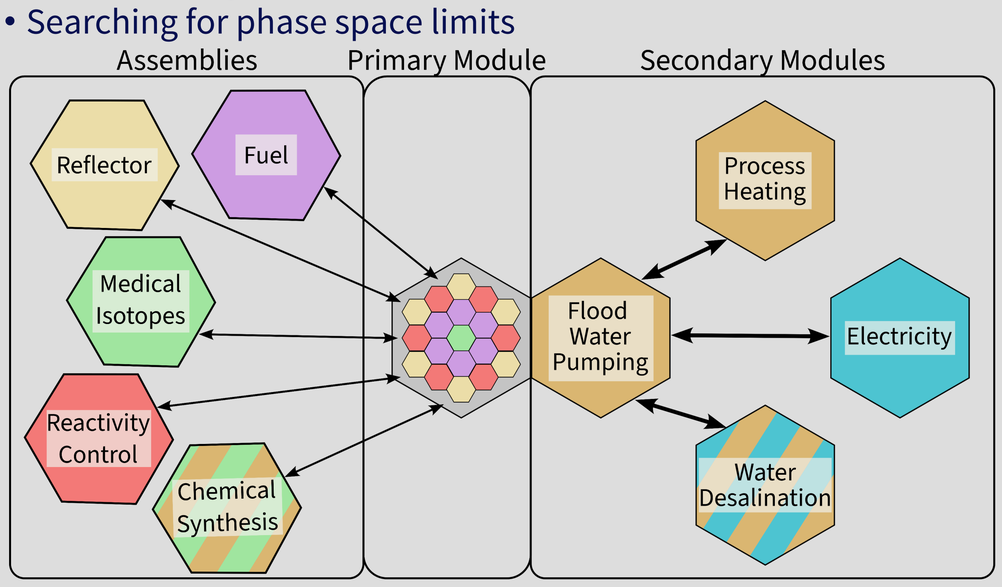
[2] Faculty of Mathematics and Physics, University of Ljubljana

anze.mihelcic@ijs.si

darwin.ijs.si

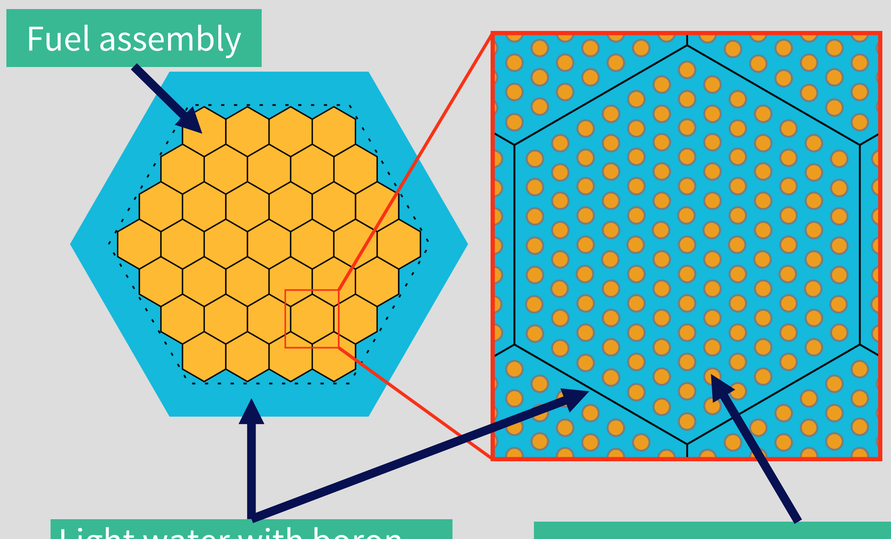
INTRODUCTION & MOTIVATION

- Dispatchable Adaptive Reactor With Interchangeable compoNents
- Flexible design for urgent and emergency situations
- Modular design
- Searching for phase space limits

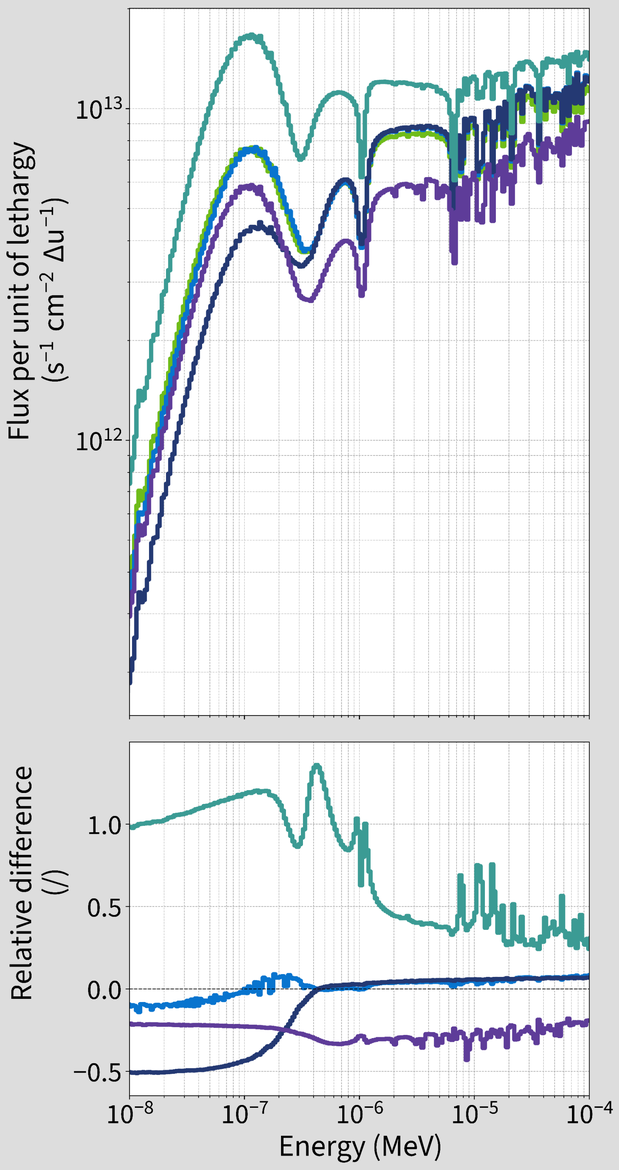


COMPUTATIONAL MODEL

- Serpent 2.2.0 & ENDF/B-VII.1 ND library
- MOX fuel (UO_2 + PuO_2)



EFFECTS ON NEUTRON SPECTRUM



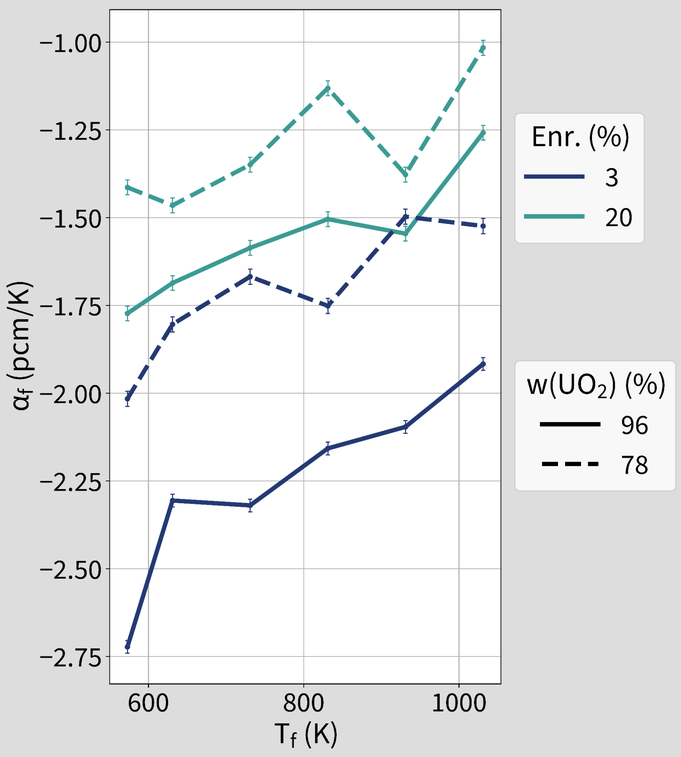
- Reference case: T_m = 560 K, c_B = 0 ppm, U enr. = 3 %, w(UO_2) = 78 %
- Case 1 (T_m = 600 K): thermal peak shift
- Case 2 (c_B = 2500 ppm): thermal flux decrease
- Case 3 (U enr. = 20 %): thermal flux decrease
- Case 4 (w(UO_2) = 96 %): thermal flux increase

CONCLUSIONS

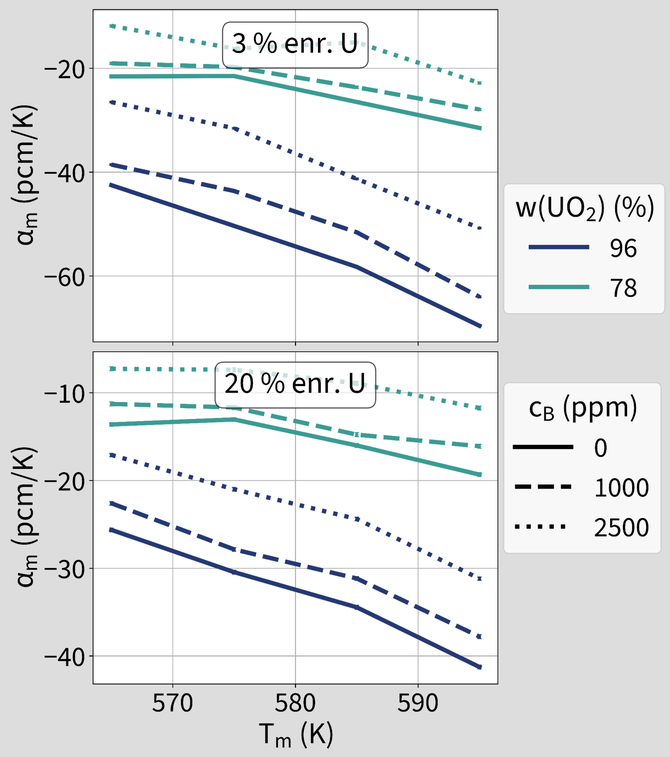
- $\alpha_m < 0$ for all cases (3 % ≤ U enr. ≤ 20 %, 78 % ≤ w(UO_2) ≤ 96 %, c_B ≤ 2500 ppm)
- Higher U enrichment and lower w(UO_2) ⇒ weakens α_m
- Higher boron concentration ⇒ weakens α_m
- $\alpha_f < 0$ for all cases (3 % ≤ U enr. ≤ 20 %, 78 % ≤ w(UO_2) ≤ 96 %)
- Higher U enrichment and lower w(UO_2) ⇒ weakens α_f
- Fission reaction rate decrease with temperature & capture reaction rate increase with temperature ⇒ $\alpha_{m/f} < 0$

TEMPERATURE FEEDBACK COEFFICIENT

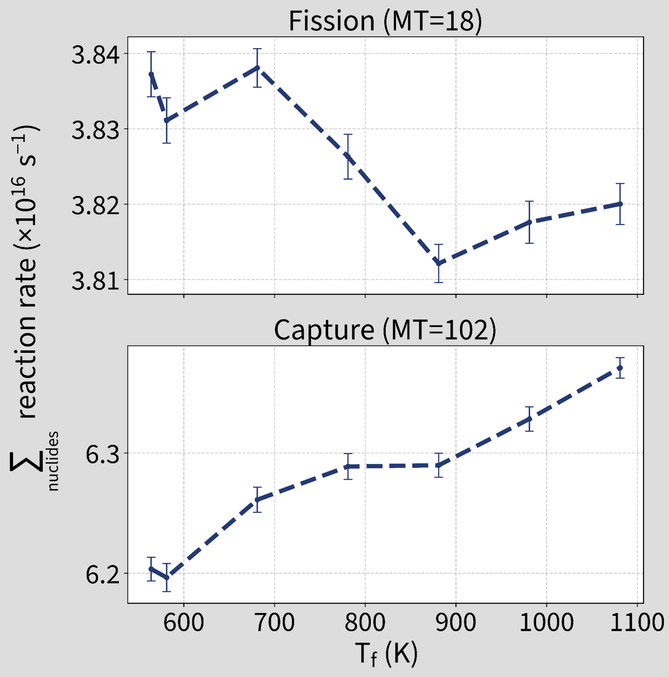
Fuel temperature – T_f



Moderator temperature - T_m



- Temperature change ⇒ reaction rates change ⇒ change in k_{eff}
- Example of changes in T_f for a case with 3 % U enr. and 96 % w(UO_2)



Average relative contribution to total reaction rate (%)

Nuclide	Fission	Capture
^{235}U	18.9	3.4
^{238}U	0.1	0.5
^{239}Pu	36.3	12.0
^{240}Pu	0.7	55.1
^{241}Pu	43.5	9.2
^{242}Pu	0.5	19.6

- Reaction rates for individual nuclide, normalised to reaction rate at T_f = 560 K