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Preliminary results for the C5G7-2D Benchmark using the PARAFISH code

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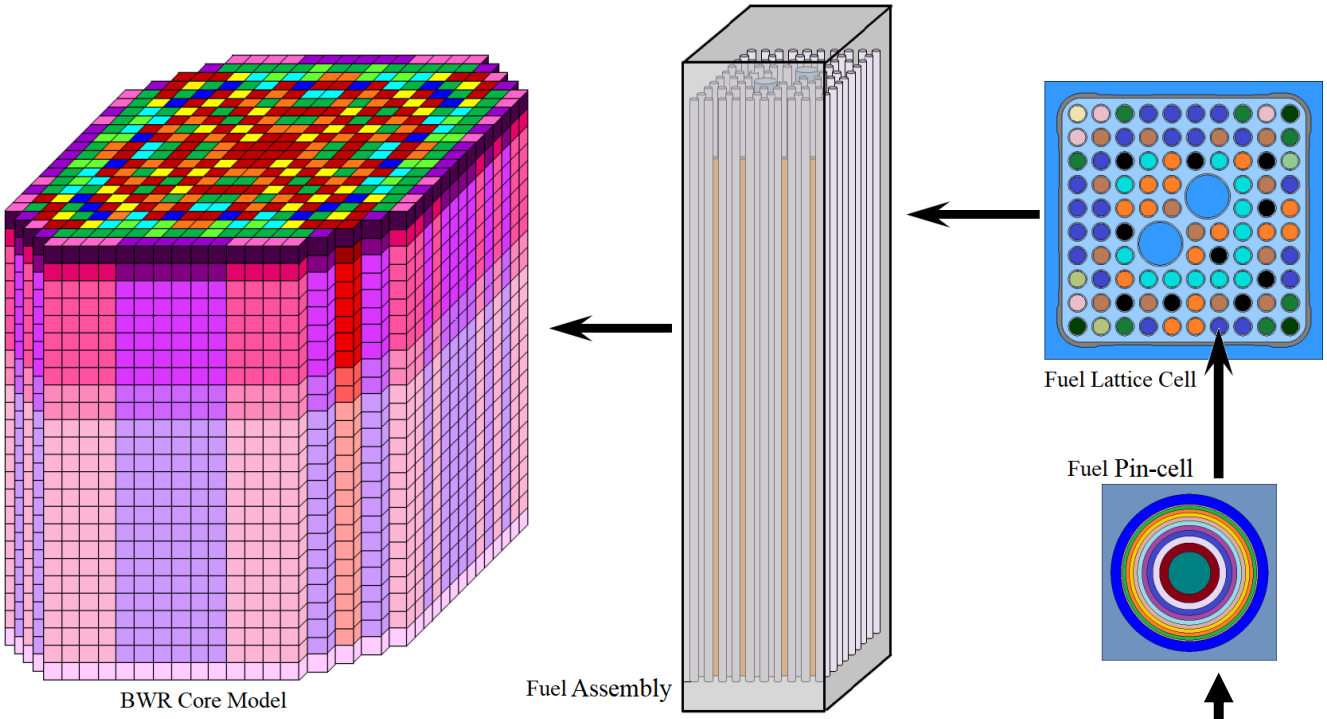
Introduction

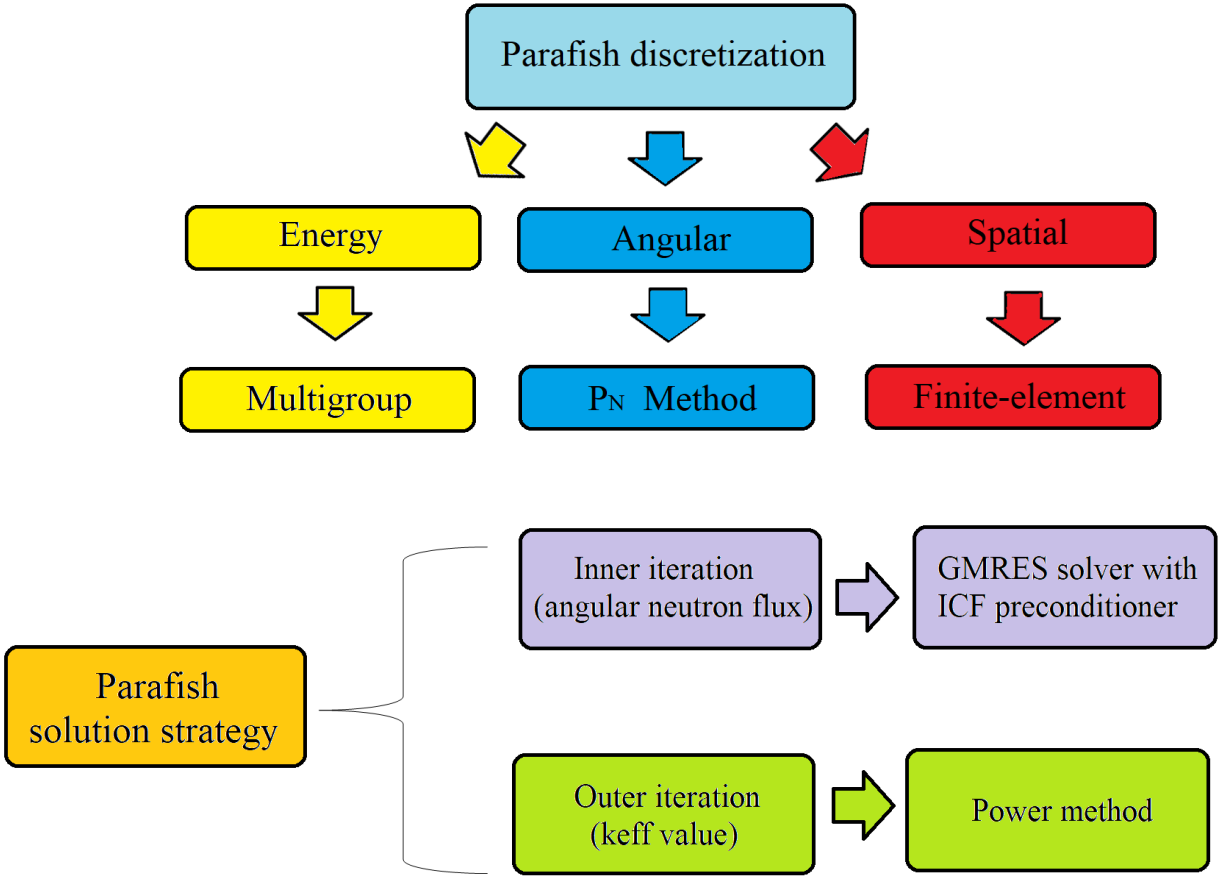


$$\frac{1}{V(E)}\frac{\partial\psi(\vec{r},E,\hat{\Omega},t)}{\partial t}+\hat{\Omega}\cdot\vec{\nabla}\psi(\vec{r},E,\hat{\Omega},t)+\Sigma_t(\vec{r},E,t)\psi(\vec{r},E,\hat{\Omega},t)=S(\vec{r},E,\hat{\Omega},t)$$

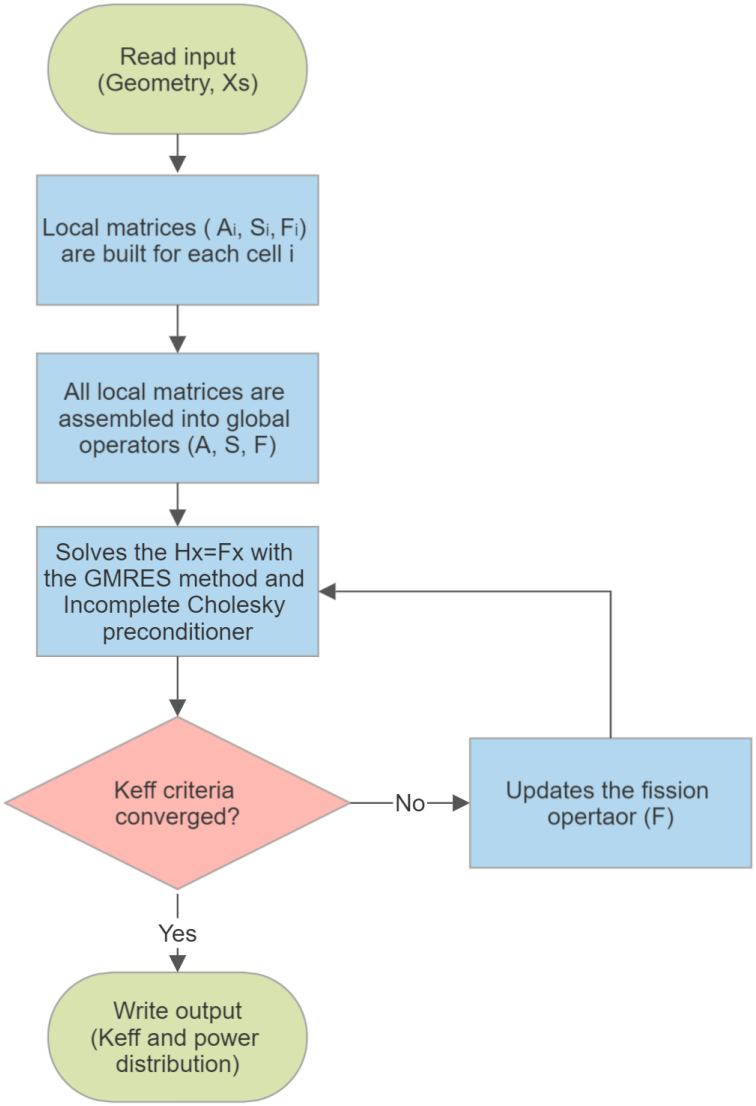
Neutron transport equation

PARAFISH neutron code

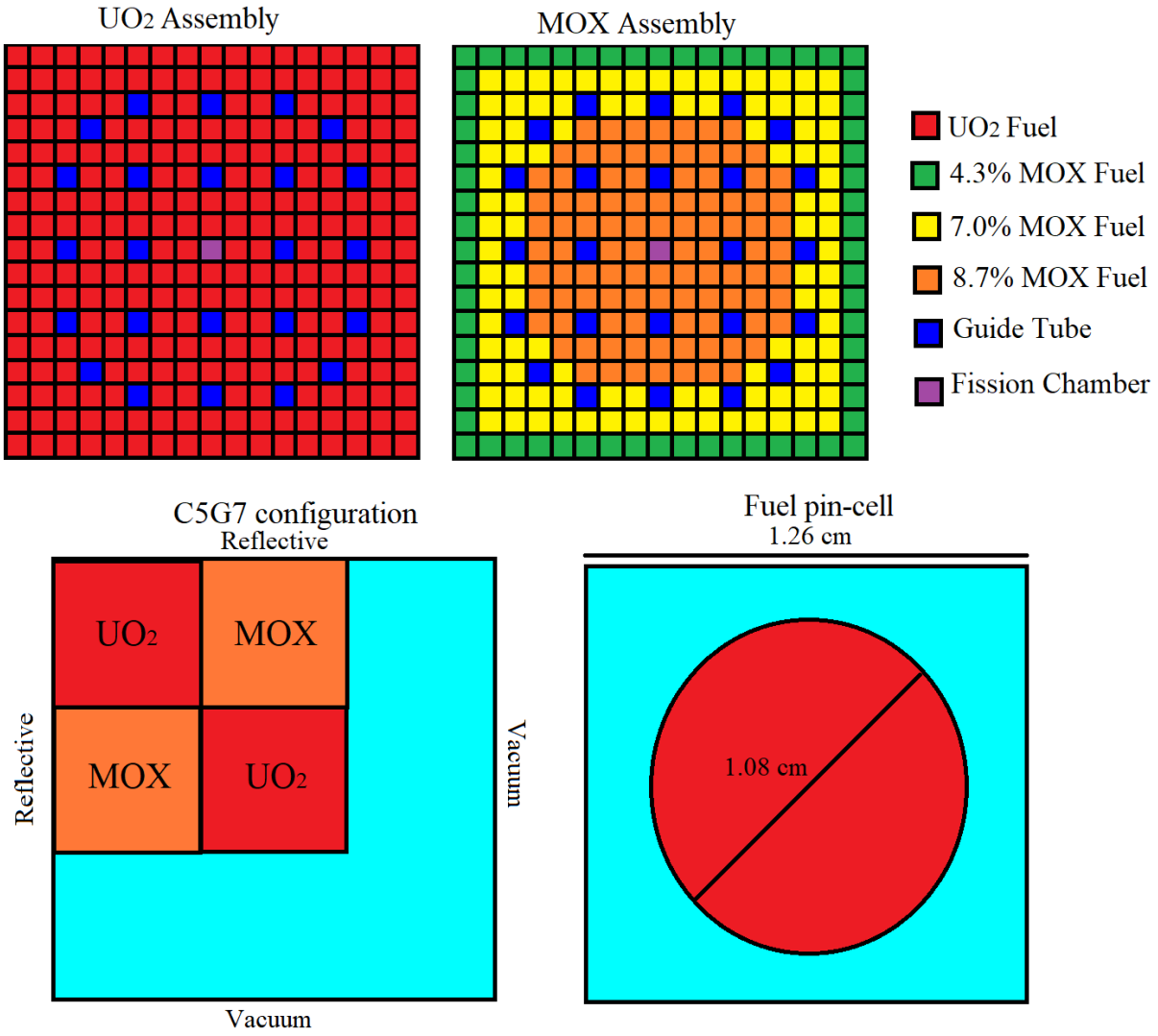
$$\hat{A}\vec{x} = \frac{1}{k_{eff}}\hat{F}\vec{x} + \hat{S}\vec{x}$$



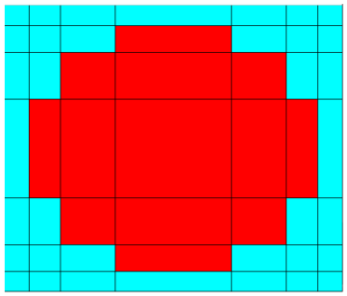
PARAFISH neutron code



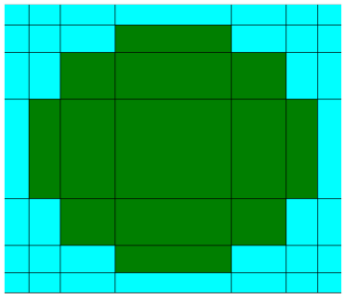
C5G7-2D Benchmark



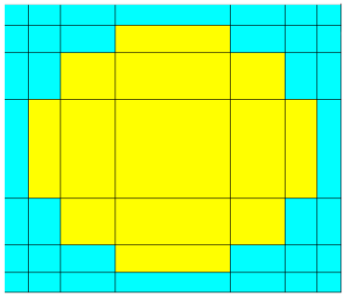
Results (Pin-cells)



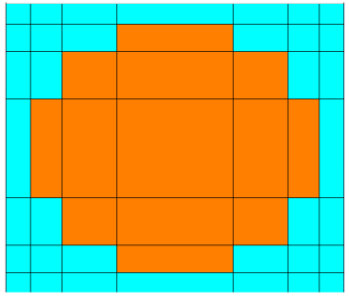
UO_2 Fuel pin-cell



4.3% MOX Fuel pin-cell



7.0% MOX Fuel pin-cell

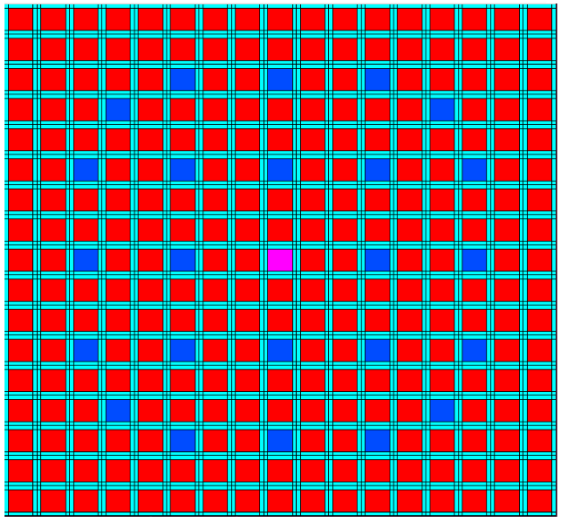


8.7% MOX Fuel pin-cell

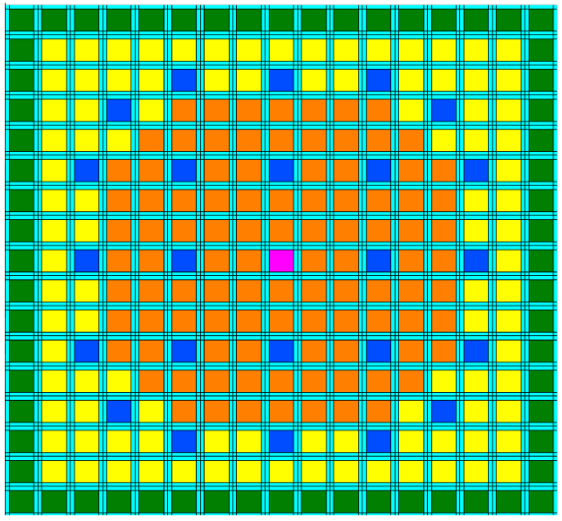
Table I. Comparison of k_{eff} for different pin-cells.

Pin type	PARAFISH (P_7)	AZTRAN (S_8)	error	HELIOS [21]	error
UO_2	1.32286	1.32288	2 pcm	1.32660	282 pcm
$MOX(4.3\%)$	1.12986	1.13130	127 pcm	1.13544	491 pcm
$MOX(7.0\%)$	1.15279	1.15501	192 pcm	1.15920	553 pcm
$MOX(8.7\%)$	1.16535	1.16794	221 pcm	1.17208	574 pcm

Results (Assemblies)



UO_2 Assembly



MOX Assembly

Table II. Comparison of k_{eff} for different Assemblies configuration.

Assembly type	PARAFISH (P_3)	AZTRAN (S_4)	error	HELIOS [21]	error
UO_2 (Fully)	1.33498	1.33340	118 pcm	1.33517	15 pcm
UO_2 (Partially)	0.97038	0.97245	212 pcm	0.96246	822 pcm
MOX (Fully)	1.17376	1.17710	283 pcm	1.18599	1031 pcm
MOX (Partially)	0.88266	0.88713	503 pcm	0.88745	539 pcm

Results (Assemblies)

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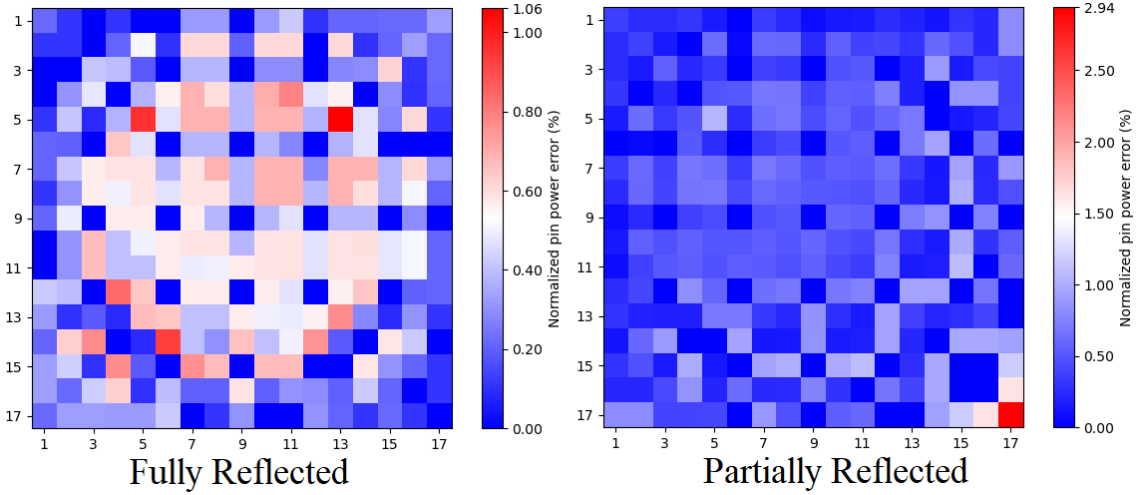
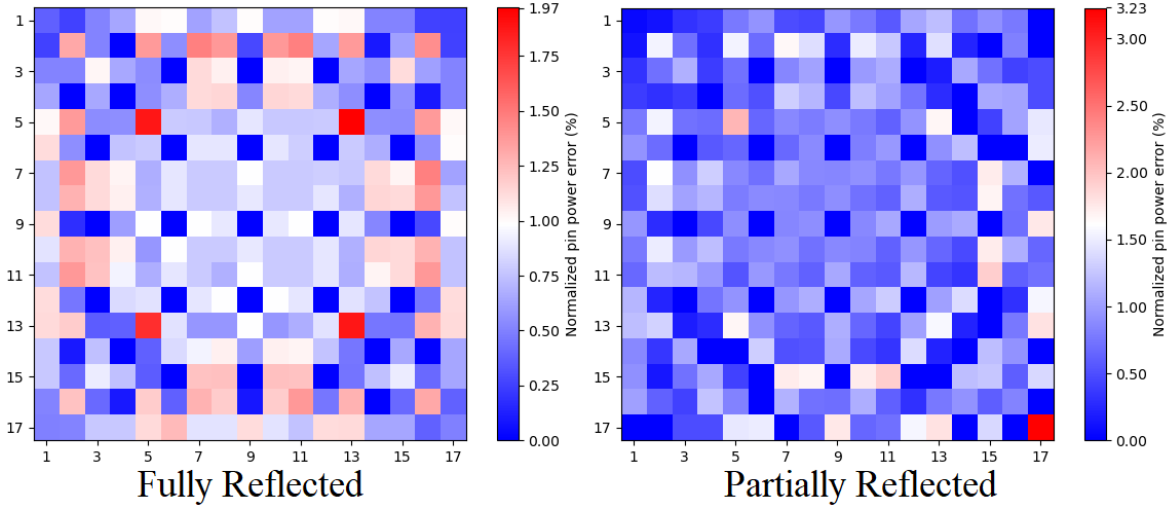
UO_2 Assembly



MOX Assembly



Results (C3)

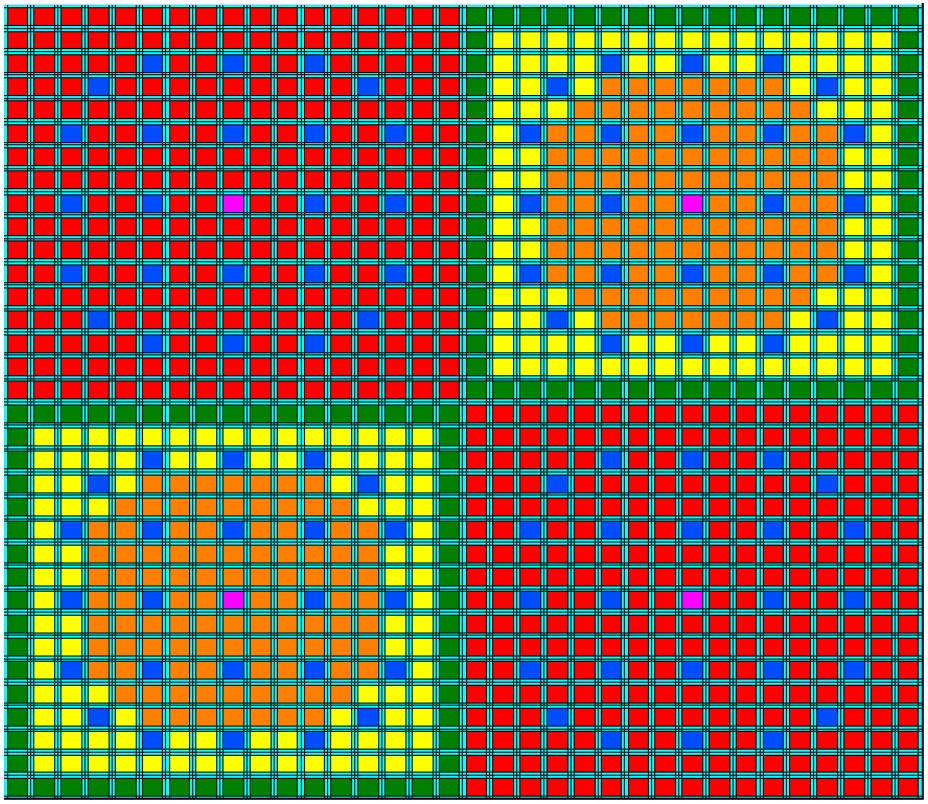
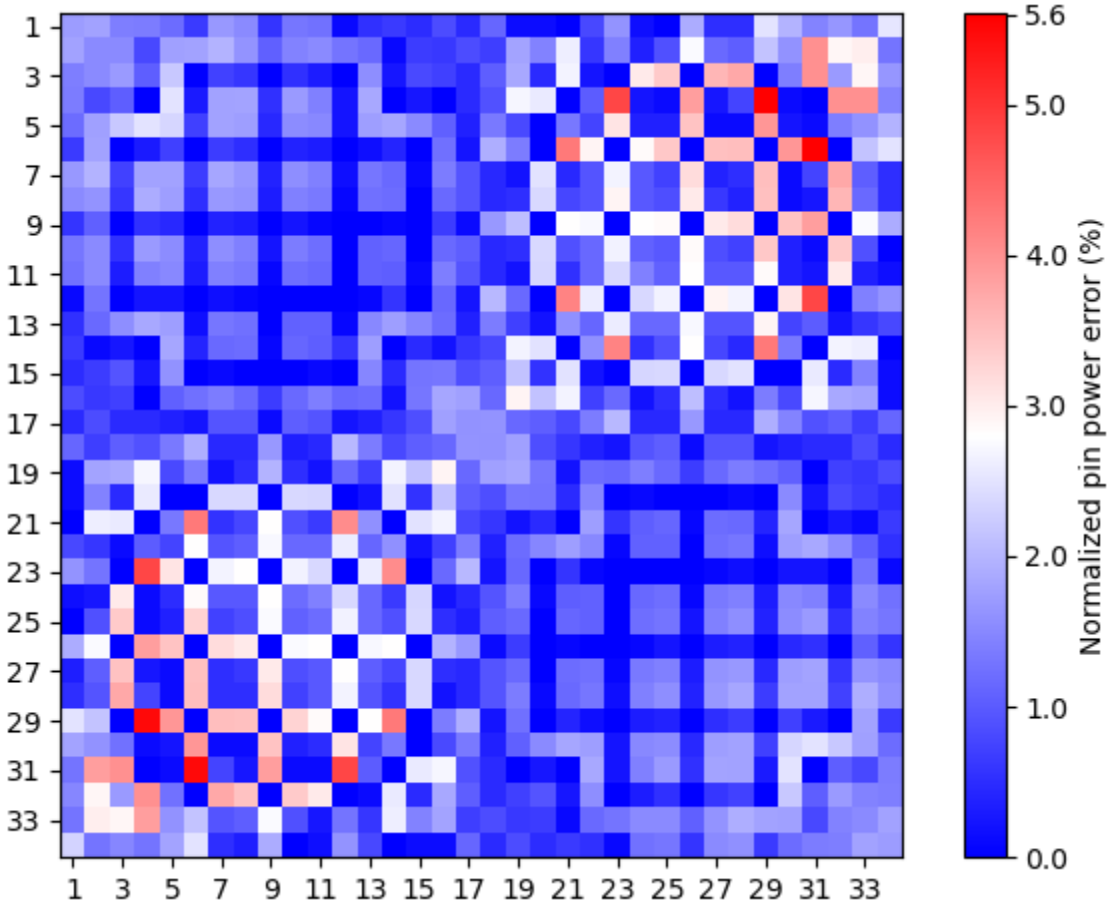


Table III. Comparison of k_{eff} for the C3 configuration.

PARAFISH (P_1)	AZTRAN (S_2)	error	HELIOS [21]	error
1.25860	1.26036	139 pcm	1.26231	293 pcm

Results (C3)


1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
5.6
5.0
4.0
3.0
2.0
1.0
0.0
Normalized pin power error (%)

Results (C5G7-2D)

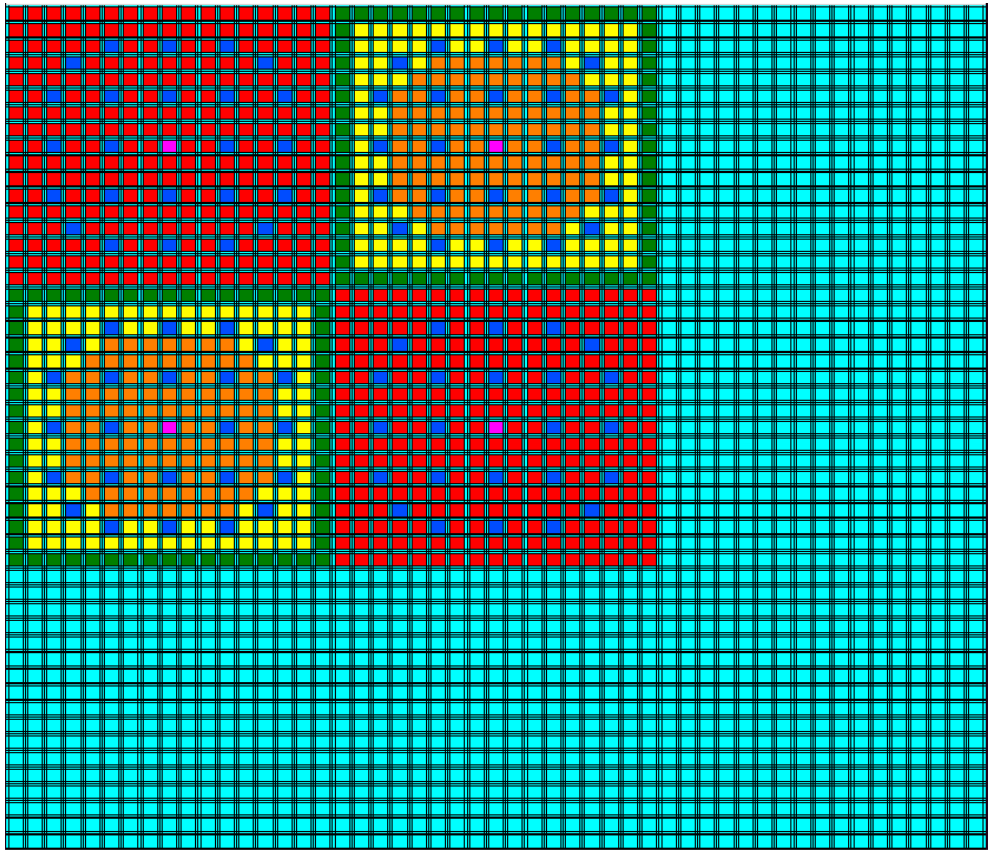
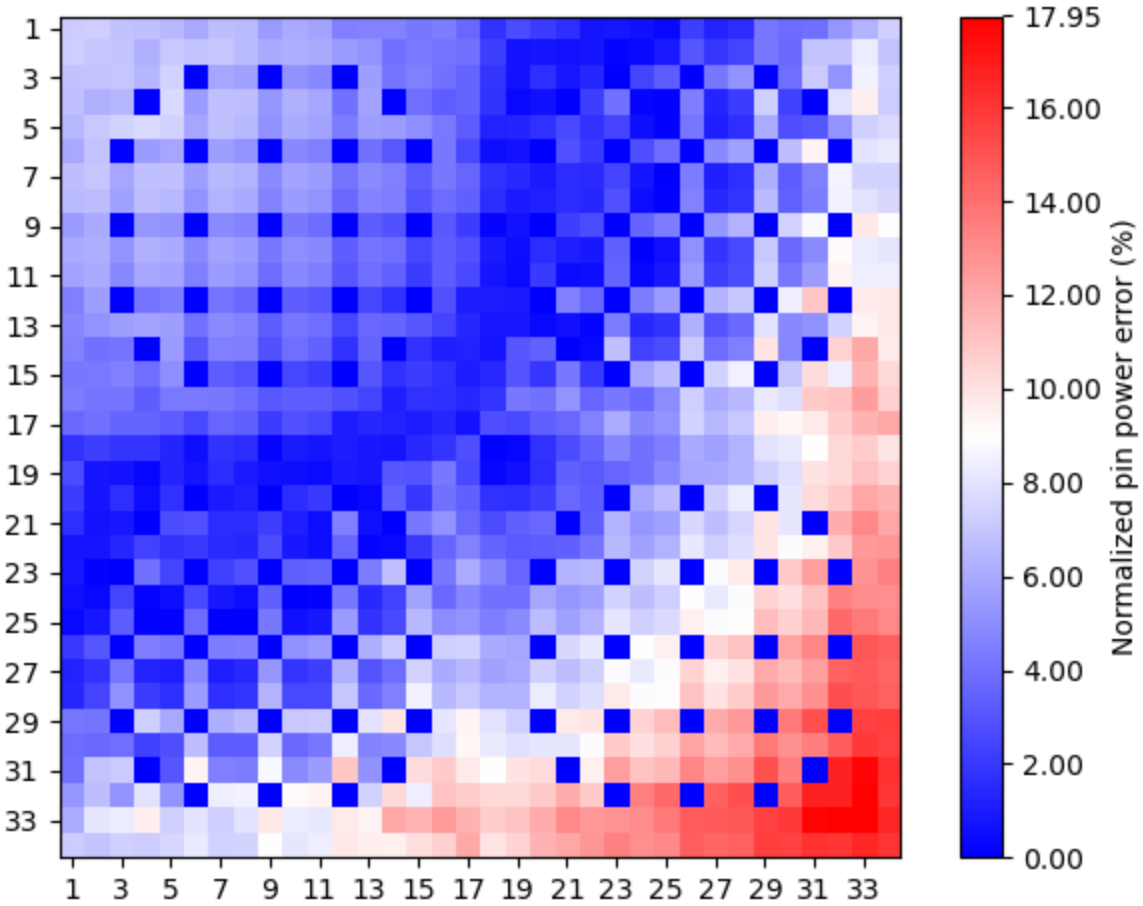


Table IV. Comparison of k_{eff} for the C5G7-2D configuration.

PARAFISH (P_1)	AZTRAN (S_2)	error	MCNP [14]	error
1.18332	1.18651	268 pcm	1.18655	272 pcm

Results (C5G7-2D)



Conclusions

- PARAFISH agrees very well with the AZTRAN code for calculations modeled with a degree of detail (pin-cell and assemblies models).

- Modeling more challenging configurations (C3 and C5G7) leads to more significant differences of around 5% and 17%, respectively (Coarse discretization and poor convergence criterion due to “Memory Leak”).

- PARAFISH has the potential to become a reliable neutron transport solver, since is closer to AZTRAN when both have a high spatial-angular discretization

- It has been identified that PETSc library will be suitable and will fix the memory leak, so an exhaustive analysis of the C5G7 will take place to demonstrate the real capacities of PARAFISH.