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Steady-State Neutronic Assessment of a Micro Reactor Based on NASA's Krusty Project

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INTRODUCTION

Micro reactor: Provide electricity and heat in remote or urban regions due to its compact size and transportability. They can be integrated into microgrids with other sustainable technologies. Power less than 10MWe.

Kilopower: Kilopower project developed preliminary concepts and technologies that could be used for an affordable fission nuclear power system to enable long-duration stays on planetary surfaces.

KRUSTY: The KRUSTY project (Kilopower Using Stirling Technology), achieved successful testing in 2018, being considered by the team for a lunar experiment.

Objectives: Modeling and analysis of a Krusty-based micro reactor using MCNP. Initially obtaining the main neutronic aspects.

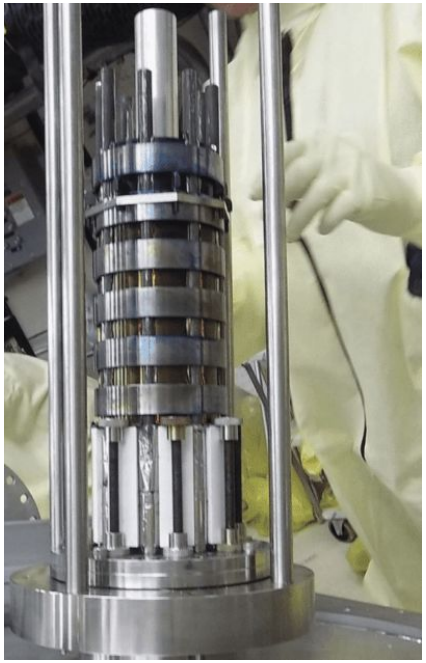
METODOLOGY

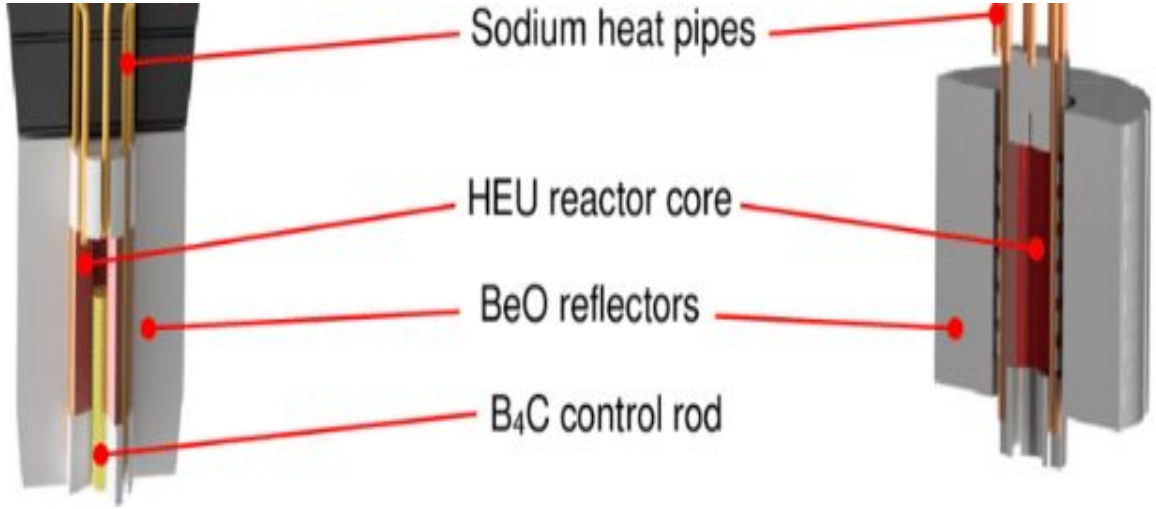
1) Literature review.

2) Modeling and analysis of Krusty-based micro reactor using MCNP.

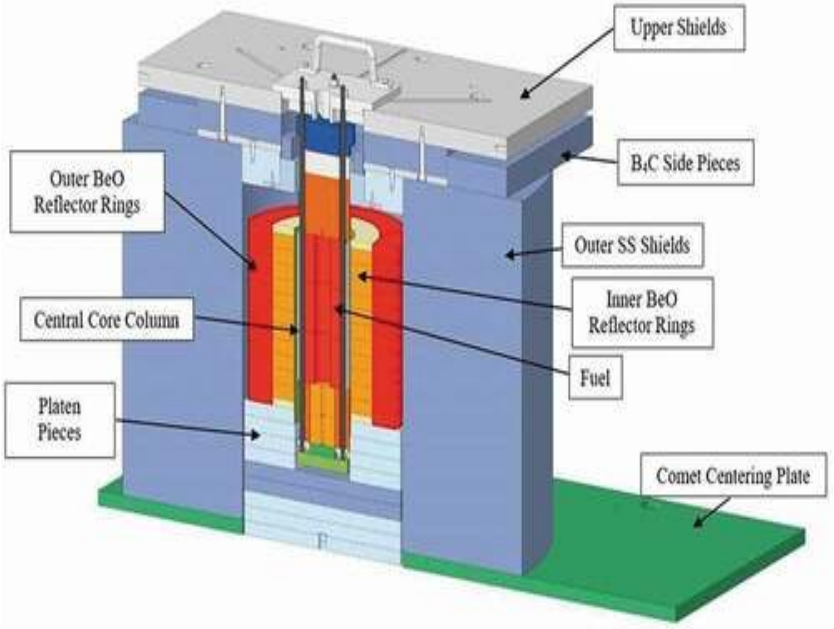
3) Assessment of neutronic parameters.

KRUSTY PROJECT

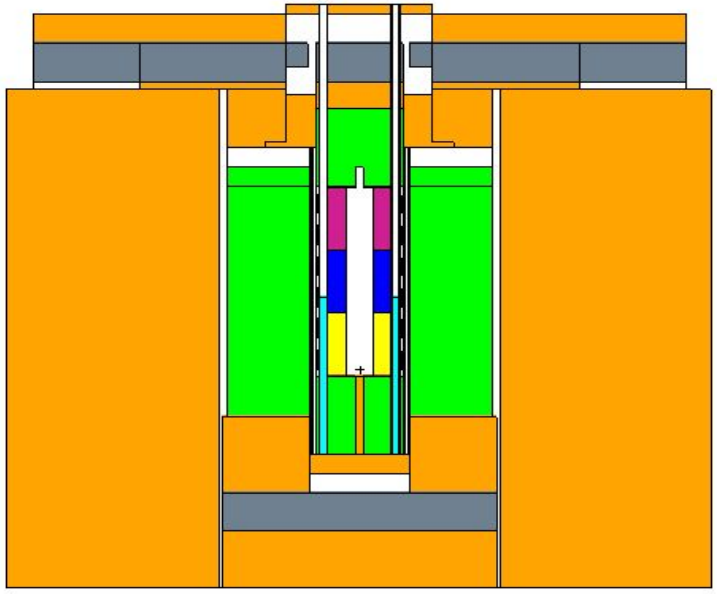




KRUSTY RADIAL GEOMETRY

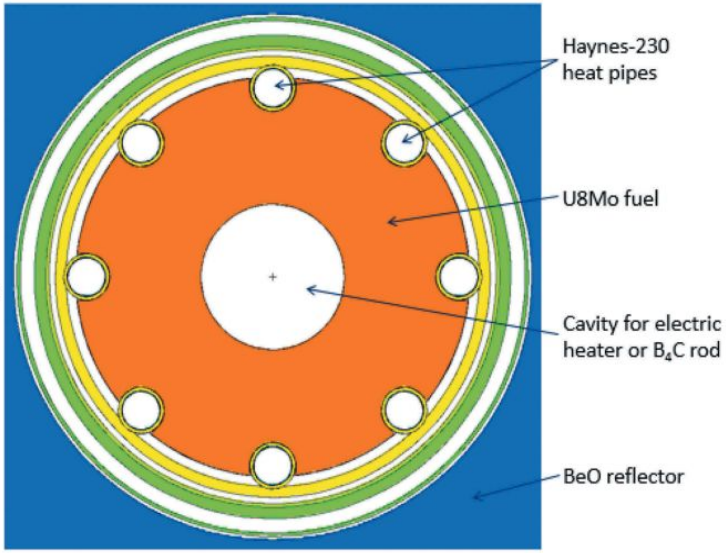


NASA PROJECT

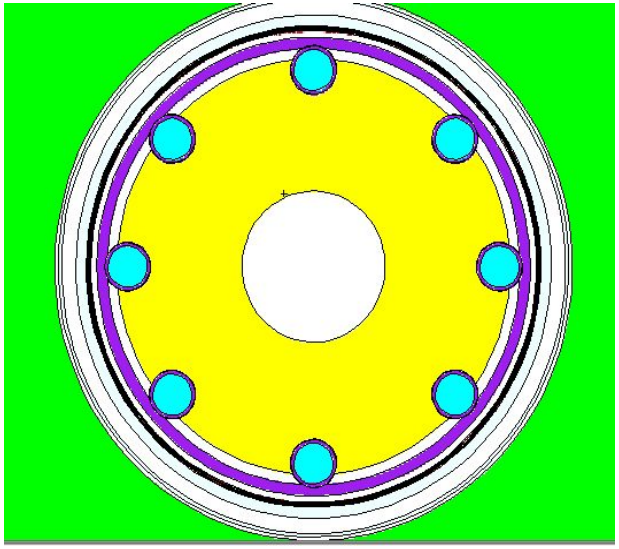


MCNP 6.2

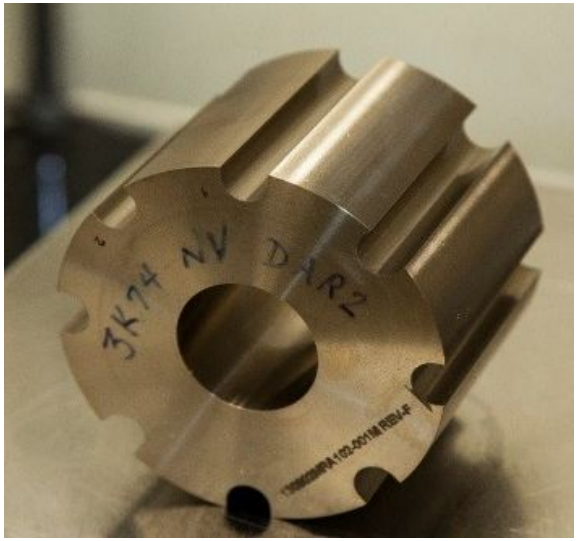
KRUSTY AXIAL GEOMETRY



NASA PROJECT



MCNP 6.2



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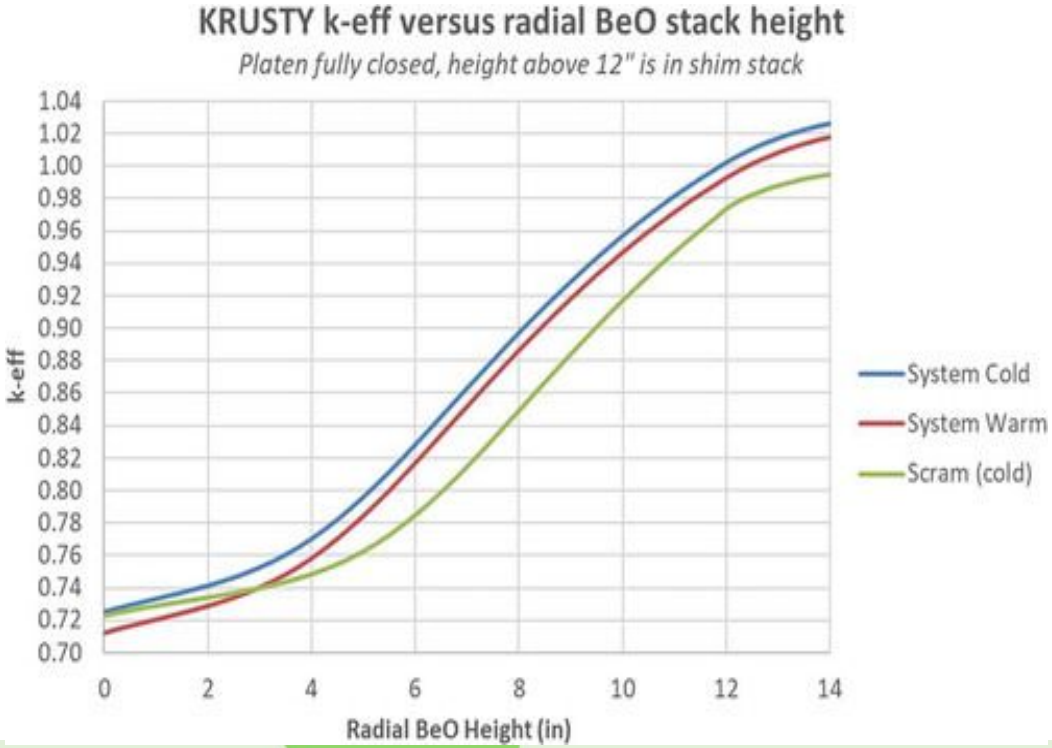
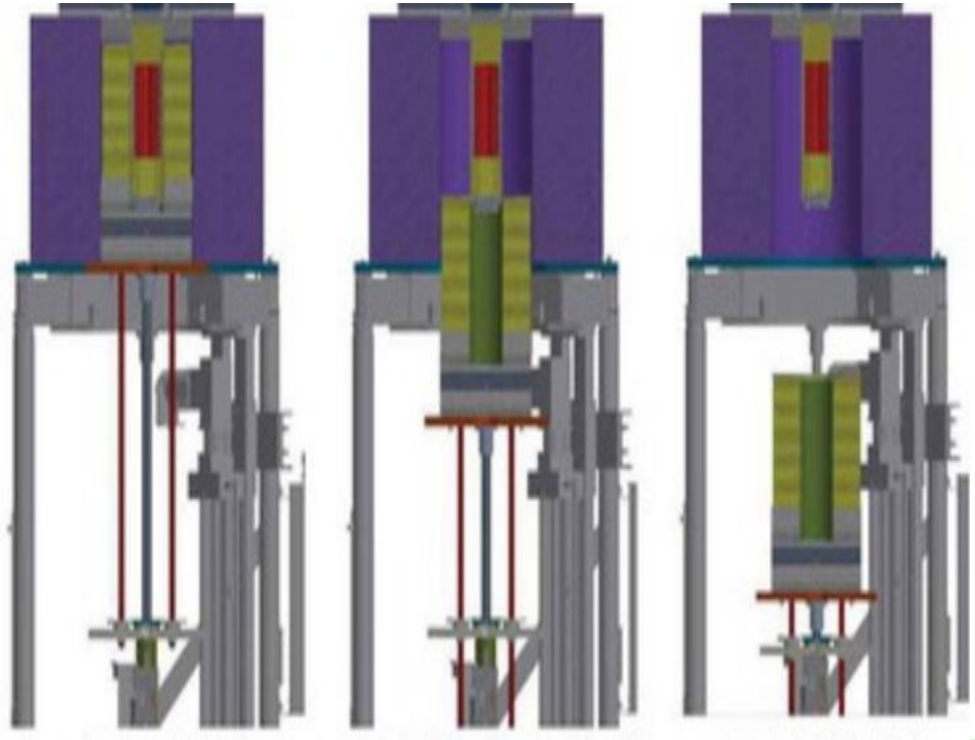
MODEL CHECK


KRUSTY k-eff versus radial BeO stack height
Platen fully closed, height above 12" is in shim stack
k-eff
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0.74
0.72
0.70
0
2
4
6
8
10
12
14
Radial BeO Height (in)
System Cold
System Warm
Scram (cold)

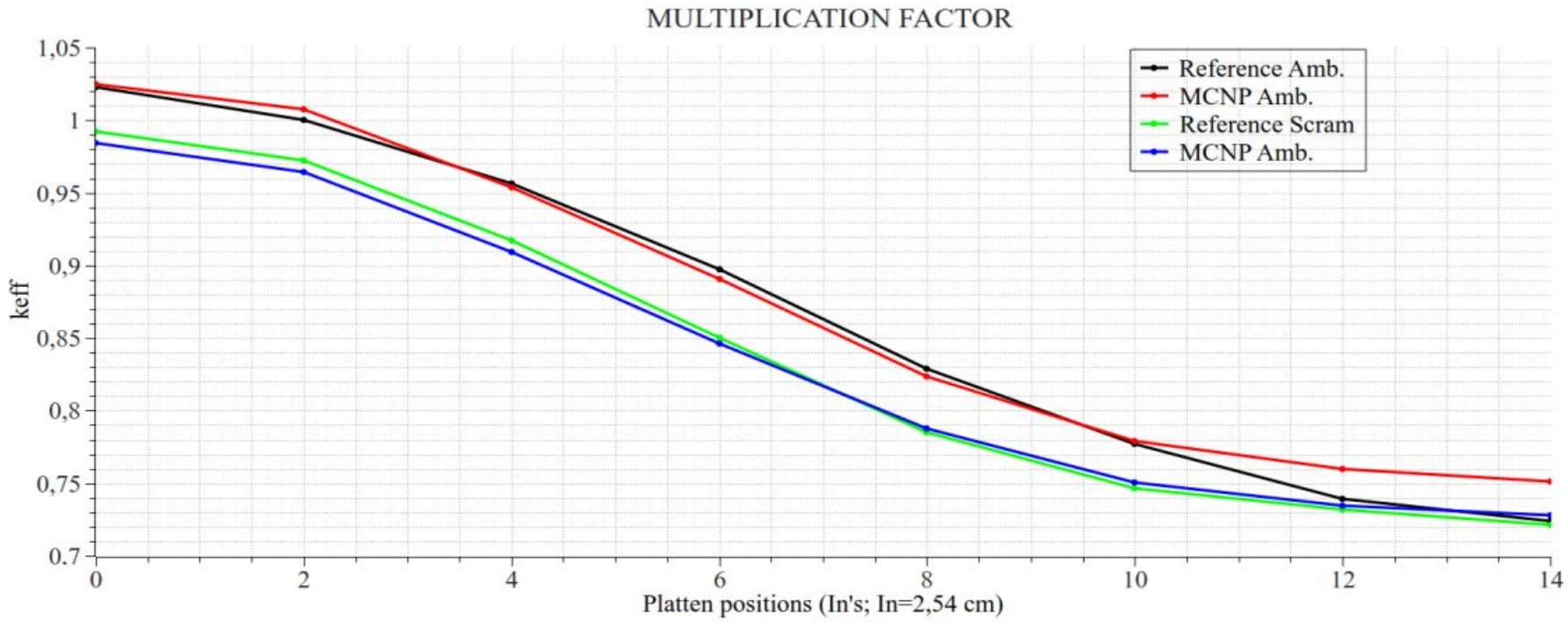


MODEL CHECK

The results were obtained with:

- **MCNP 6.2**
- **ENDF 7.0 for the cross-sections.**
- **Room temperature.**
- **230 cycles disregarding the first 30.**
- **15 thousand initial particles which is equivalent to the reference.**

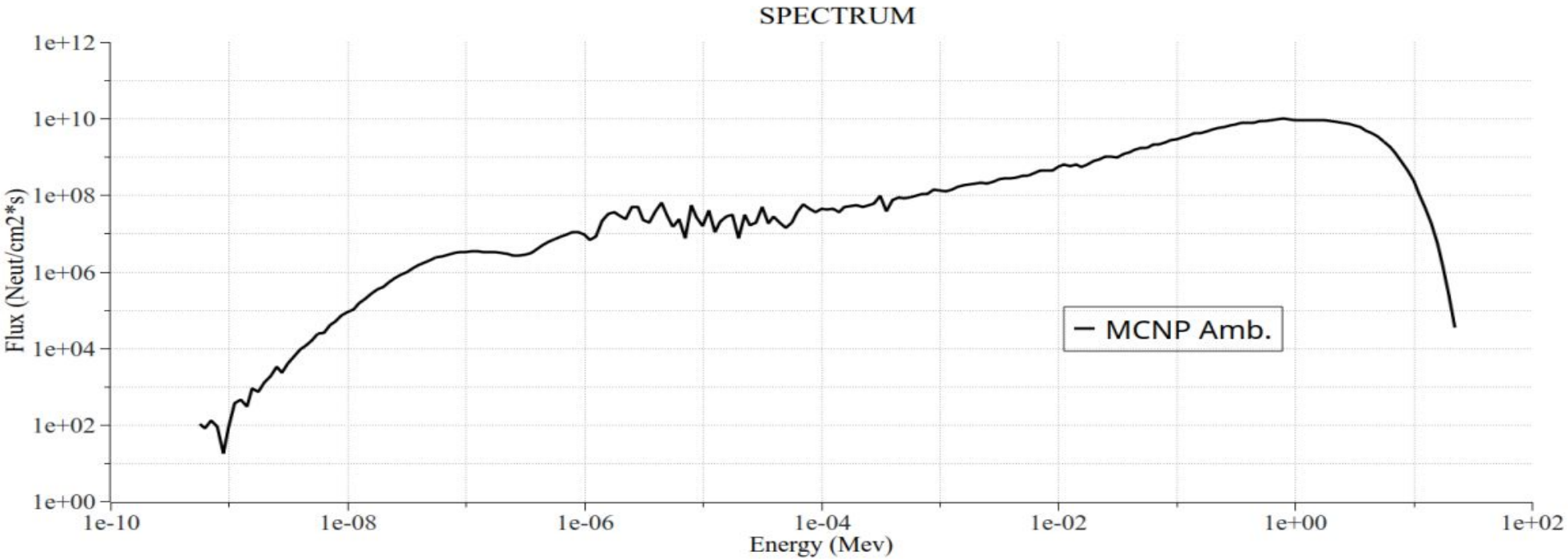
MODEL CHECK


MULTIPLICATION FACTOR
Reference Amb.
MCNP Amb.
Reference Scram
MCNP Amb.
keff
1,05
1
0,95
0,9
0,85
0,8
0,75
0.7
0
2
4
6
8
10
12
14
Platten positions (In's; In=2,54 cm)

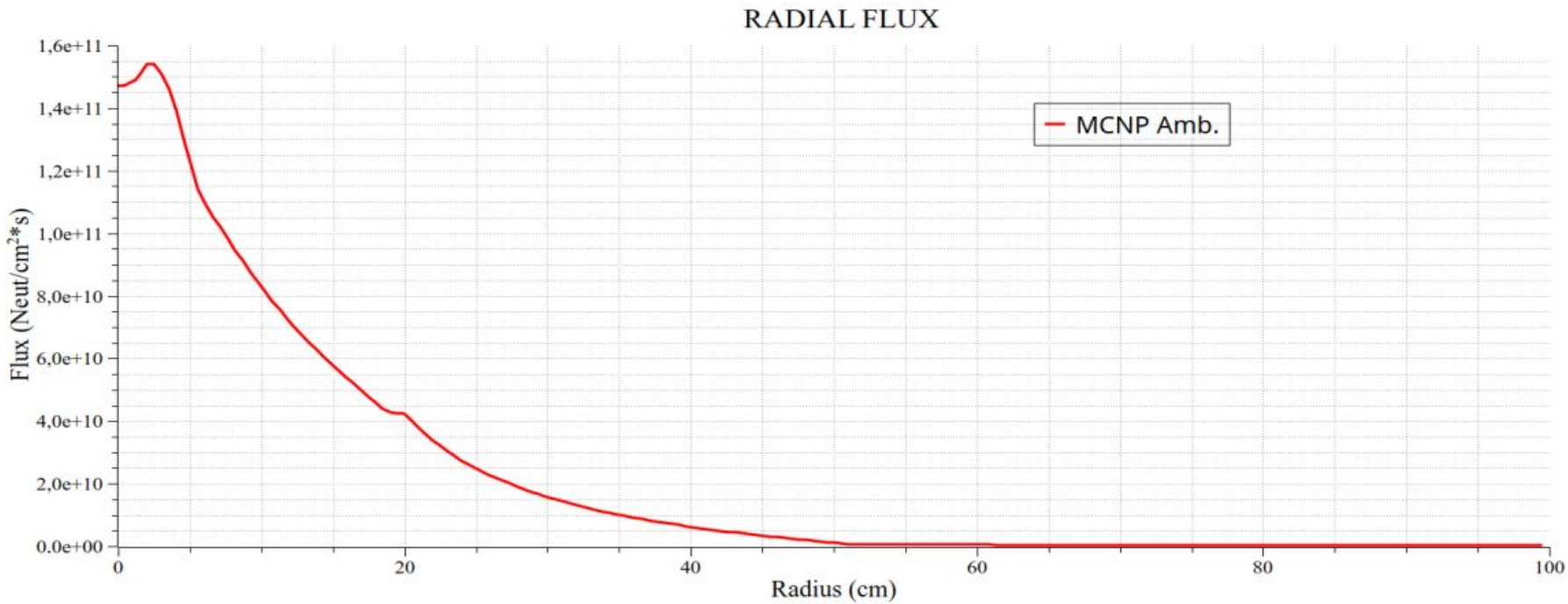
MODEL CHECK

Radial BeO Heigth (in)	Cold		Scram		Difference		Cold	Scram
	REF	MCNP	REF	MCNP	cold	scram	σ	σ
0	1,02290	1,02464	0,99250	0,98455	-174	795	45	47
2	1,00100	1,00756	0,97290	0,96422	-656	868	46	40
4	0,95660	0,95381	0,91710	0,90907	279	803	46	42
6	0,89740	0,89055	0,84990	0,84588	685	402	40	39
8	0,82870	0,82404	0,78480	0,78768	466	-288	35	42
10	0,77720	0,77924	0,74680	0,75027	-204	-347	36	32
12	0,73940	0,75978	0,73210	0,73479	-2038	-269	36	33
14	0,72410	0,75116	0,72110	0,72779	-2706	-669	35	32

NEUTRONIC ANALYSES



NEUTRONIC ANALYSES



FUTURES

Works to be done:

- **Perform tests at operating temperature.**
- **Promote a fuel composition that meets international agreements for enrichment.**
- **Perform burn tests**

ACKNOWLEDGEMENT

CAPES

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FAPEMIG

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[6]Sanchez, Rene, et al. "Kilowatt Reactor Using Stirling TechnologY (KRUSTY) Component-Critical Experiments." Nuclear Technology 206.sup1: S56-S67 (2020)