Application of MCS Code to Yonggwang Unit 3 Cycle 1 BOC Analysis

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INTRODUCTION

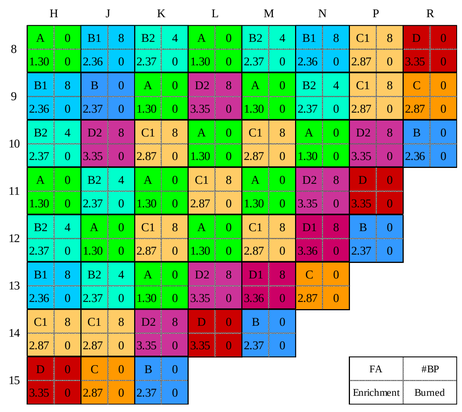
- A in-house MC code of CORE at UNIST, MCS
- Large scale reactor analysis with 3-D geometry and various feedbacks
- Solve large-scale reactor to Yonggwang Unit 3 Cycle 1 at BOC
- Comparison to the in-house two step code system STREAM/RAST-K 2.0.

YGN3 CORE DESIGN

Core Parameters of YGN3

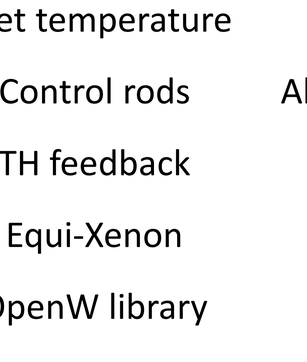
Parameters	Value	Unit
Reactor type	PWR	
Thermal power	2815	MWt
Number of FAs	177	
Fuel rods at each FA	236	
FA type	16x16	
Fuel material	UO_2	
BA material	Gd_2O_3	
Active core height	381	cm

Loading Pattern

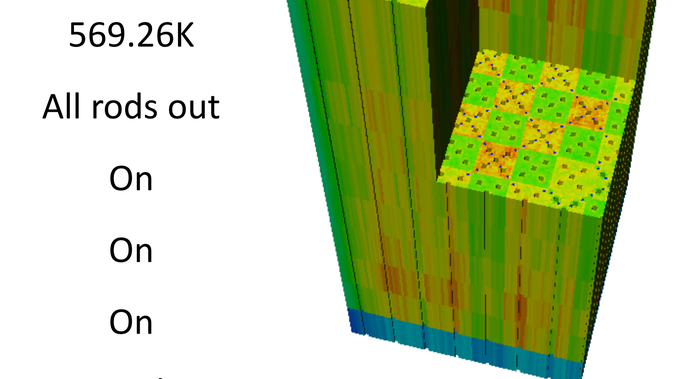


CODE DESCRIPTION

STREAM/RAST-K Flowchart



MCS Flowchart



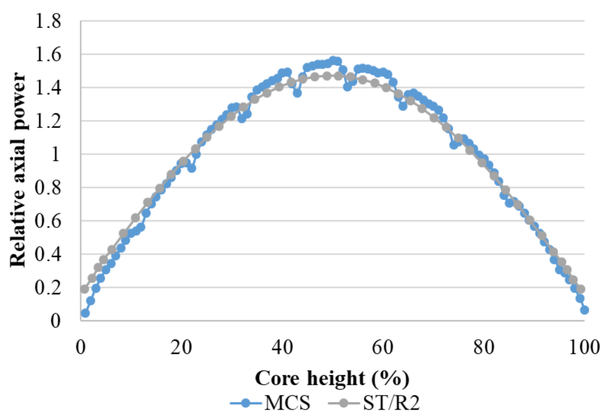
RESULTS

Summary of MCS and ST/R2 Simulation

	HZP	HFP
Power	2815 MW(t)	2815 MW(t)
Power Rating	0 %	100 %
Pressure	158.18 kg/cm^2	158.18 kg/cm^2
Inlet temperature	600K	569.26K
Control rods	All rods out	All rods out
TH feedback	Off	On
Equi-Xenon	Off	On
OpenW library	Off	On
XS library	ENDF-B/VII.1	ENDF-B/VII.1

Power distribution (EOC)

Axial Power Distribution (HZP)



Radial Power Distributions (HZP)

	H	J	K	L	M	N	P	R
8	0.783	0.983	1.154	0.829	1.181	1.063	1.231	1.016
	0.793	1.005	1.181	0.834	1.205	1.076	1.249	1.022
	1.217	2.292	2.322	0.547	2.053	1.230	1.532	0.559
9	0.983	1.194	0.821	1.251	0.838	1.224	1.190	0.859
	1.005	1.207	0.831	1.270	0.839	1.235	1.202	0.862
	2.292	1.093	1.164	1.510	0.152	0.923	0.991	0.393
10	1.154	0.821	1.143	0.796	1.169	0.851	1.138	0.575
	1.181	0.831	1.157	0.793	1.176	0.850	1.149	0.571
	2.322	1.164	1.226	-0.340	0.597	-0.152	0.984	-0.623
11	0.829	1.251	0.796	1.136	0.818	1.258	1.029	
	0.834	1.270	0.793	1.138	0.817	1.268	1.023	
	0.547	1.510	-0.340	0.195	-0.142	0.846	-0.592	
12	1.181	0.838	1.169	0.818	1.156	1.097	0.580	
	1.205	0.839	1.176	0.817	1.167	1.105	0.574	
	2.053	0.152	0.597	-0.142	1.014	0.661	-0.979	
13	1.063	1.224	0.851	1.258	1.097	0.689		
	1.076	1.235	0.850	1.268	1.105	0.680		
	1.230	0.923	-0.152	0.846	0.661	-1.234		
14	1.231	1.190	1.138	1.029	0.580			
	1.249	1.202	1.149	1.023	0.574			
	1.532	0.991	0.984	-0.592	-0.979			
15	1.016	0.866	0.575					
	1.022	0.862	0.571					
	0.559	-0.485	-0.623					

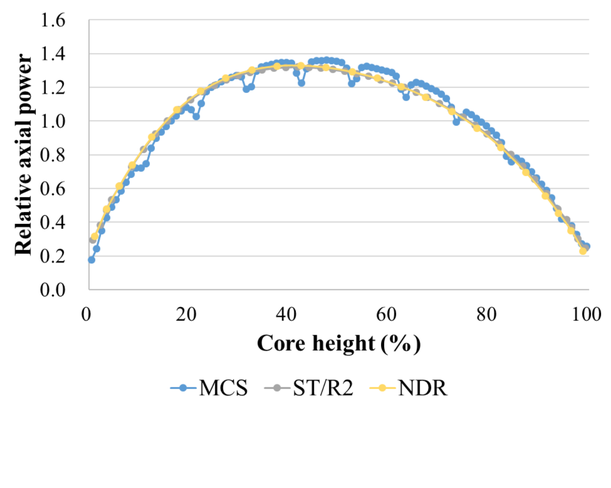
MCS / ST/R2 / Rel. Error(%)

RMS	1.122
Min	0.142
Max	2.322

CBC Comparison

Core status	Critical Boron Concentration (ppm) NDR	ST/R2	MCS	Differences (ppm) MCS-NDR	MCS-ST/R2
HZP	-	1115	1114±1	-	-1
HFP	802	790	796±1	-6	6

Axial Power Distribution (BOC)



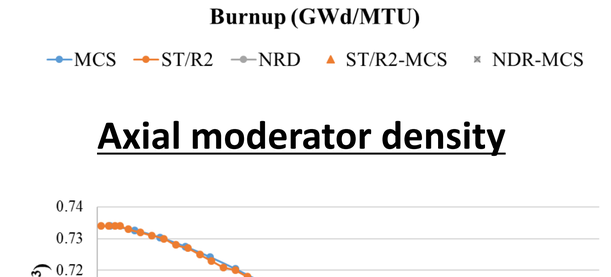
Radial Power Distributions (BOC)

	H	J	K	L	M	N	P	R
8	0.850	1.036	1.201	0.866	1.186	1.042	1.182	0.980
	0.815	1.016	1.184	0.847	1.189	1.052	1.204	1.000
	-4.075	-1.963	-1.390	-2.125	0.273	0.981	1.894	2.027
9	1.036	1.250	0.876	1.263	0.857	1.193	1.145	0.839
	1.016	1.209	0.849	1.255	0.845	1.205	1.166	0.855
	-1.963	-3.249	-3.008	-0.590	-1.329	0.981	1.834	1.925
10	1.201	0.876	1.174	0.824	1.162	0.852	1.104	0.574
	1.184	0.849	1.156	0.807	1.161	0.851	1.124	0.577
	-1.390	-3.008	-1.551	-2.046	-0.098	-0.126	1.790	0.638
11	0.866	1.263	0.824	1.136	0.831	1.220	1.002	
	0.847	1.255	0.807	1.130	0.824	1.237	1.008	
	-2.125	-0.590	-2.046	-0.509	-0.823	1.348	0.632	
12	1.186	0.857	1.162	0.831	1.137	1.072	0.579	
	1.189	0.845	1.161	0.824	1.147	1.087	0.583	
	0.273	-1.329	-0.098	-0.823	0.840	1.407	0.605	
13	1.042	1.193	0.852	1.220	1.072	0.682		
	1.052	1.205	0.851	1.237	1.087	0.686		
	0.981	0.981	-0.126	1.348	1.407	0.583		
14	1.182	1.145	1.104	1.002	0.579			
	1.204	1.166	1.124	1.008	0.583			
	1.894	1.834	1.790	0.632	0.605			
15	0.980	0.839	0.574					
	1.000	0.855	0.577					
	2.027	1.925	0.638					

MCS / ST/R2 / Rel. Error(%)

RMS	1.602
Min	0.098
Max	4.075

Axial Power Distribution (EOC)



Radial Power Distributions (EOC)

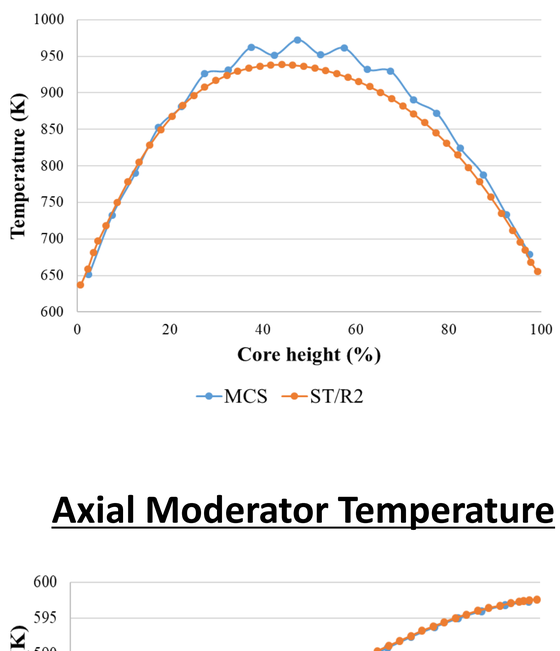
	H	J	K	L	M	N	P	R
8	0.957	1.092	1.135	0.955	1.123	1.090	1.124	0.841
	0.935	1.072	1.119	0.946	1.120	1.086	1.129	0.856
	-2.300	-1.899	-1.404	-0.958	-0.306	-0.402	0.482	1.793
9	1.092	1.139	0.958	1.246	0.950	1.118	1.095	0.750
	1.072	1.121	0.946	1.236	0.945	1.119	1.104	0.768
	-1.899	-1.588	-1.229	-0.799	-0.498	0.032	0.879	2.397
10	1.135	0.956	1.195	0.960	1.182	0.923	1.055	0.561
	1.119	0.946	1.181	0.953	1.176	0.929	1.065	0.571
	-1.404	-1.062	-1.222	-0.764	-0.512	0.641	1.001	1.744
11	0.955	1.246	0.960	1.191	0.953	1.173	0.902	
	0.946	1.236	0.953	1.182	0.952	1.183	0.916	
	-0.958	-0.799	-0.764	-0.709	-0.171	0.844	1.572	
12	1.123	0.950	1.182	0.953	1.164	1.069	0.579	
	1.120	0.945	1.176	0.952	1.163	1.080	0.589	
	-0.306	-0.498	-0.512	-0.171	-0.111	1.051	1.618	
13	1.090	1.118	0.923	1.173	1.069	0.687		
	1.086	1.119	0.929	1.183	1.080	0.699		
	-0.402	0.032	0.641	0.844	1.051	1.848		
14	1.124	1.095	1.055	0.902	0.579			
	1.129	1.104	1.065	0.916	0.589			
	0.482	0.879	1.001	1.572	1.618			
15	0.841	0.750	0.561					
	0.856	0.768	0.571					
	1.793	2.397	1.744					

MCS / ST/R2 / Rel. Error(%)

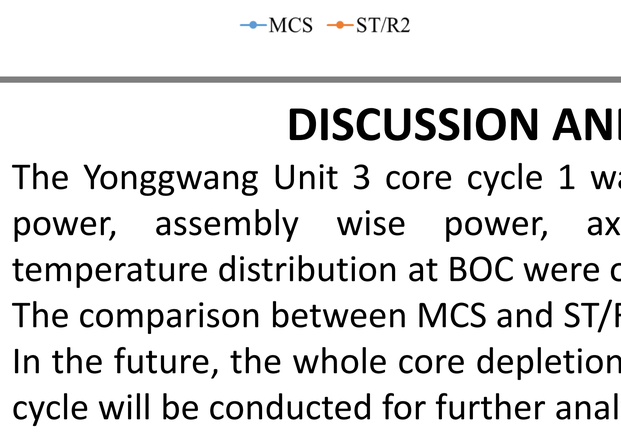
RMS	1.205
Min	0.032
Max	2.397

Critical Boron Concentration

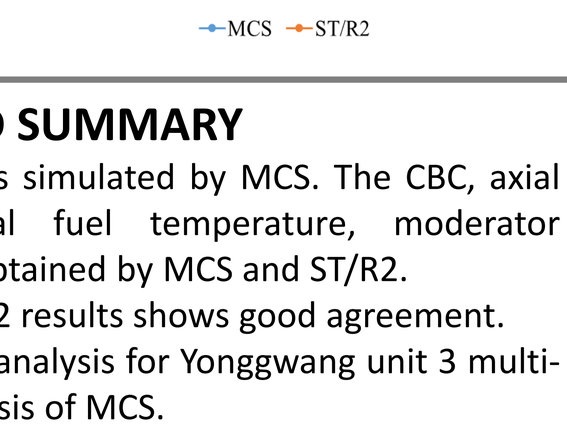
Axial Fuel Temperature



Axial moderator density



Axial Moderator Temperature



DISCUSSION AND SUMMARY

- The Yonggwang Unit 3 core cycle 1 was simulated by MCS. The CBC, axial power, assembly wise power, axial fuel temperature, moderator temperature distribution at BOC were obtained by MCS and ST/R2.
- The comparison between MCS and ST/R2 results shows good agreement.
- In the future, the whole core depletion analysis for Yonggwang unit 3 multi-cycle will be conducted for further analysis of MCS.