COBAYA3/FLICA4 vs. DYN3D/FLOCAL solutions of the V1000-MSLB-C benchmark

I.Spasov, T.Tzanov, N.Kolev (INRNE)
J.Hadek(NRI)

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OUTLINE

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2. TEST PROBLEM
3. RESULTS
4. CONCLUSIONS

INTRODUCTION

Objectives

- Test standalone COBAYA and DYN3D
- Test COBAYA3/FLICA4 and DYN3D/FLOCAL at the nodal level
- Test the COBAYA3/FLICA4 coupling scheme in Salome 5.1.5

Solvers

- Analytical Nodal Diffusion Equation Solver (ANDES) in COBAYA3
- HEXNEM2 in DYN3D

Nodalization

- COBAYA3: 6N and 30 axial nodes
- DYN3D: 1 node per hexagon and 30 axial node
- FLICA4: one TH channel per assembly
- FLOCAL: one TH channel per assembly

V1000-MSLB-C benchmark

- Core boundary conditions problem derived from the OECD V1000CT-2 MSLB benchmark
- Reference core: Kozloduy-6 Cycle 8, at 270.4 EFPD, Cb=0.3g/kgH2O, HFP initial state
- Generate APOLLO2 XS libraries for homogenized nodes, with implicit ADFs
- Use CATHARE2.5 pre-calculated TH boundary conditions
- The task is to calculate integral parameters and distributions at HZP, HFP and during the transient, for a pessimistic scenario

MSLB Benchmark Scenarios

MSLB in steam line #4 upstream of the SIV

Scenario 1

- Realistic, as used in the current licensing practice
- MCP-4 trips and the loop #4 flow reverses in 55s
- No return to power after scram
- The overcooled sector shifts counter clockwise with respect to loop 1 axis
- Max overcooling at 166s from the beginning of the transient

Scenario 2

- Pessimistic
- All MCP remain in operation
- Reduced CR absorption XS -> expected return to power
- Max overcooling dT~ - 75 K at 68s

V1000CT2 HZP states

Number	T-H conditions	Control rod positions	Scenario version
0	HZP	Groups 1-10 ARO*	
1a	HZP (near critical)	Groups 1-5 up, 6 - 81% wd, 7-10 down Rod in #90 (63;140) is 100% wd	
1b	HZP	Groups 1-10 ARI	
2	HFP	Groups 1-9 ARO Group 10 is 80% wd	
3	HZP	Groups 1-10 ARI #90 is 100% wd	1
4	HZP	Groups 1-10 ARI #63 is 100% wd	1
5	HZP	Groups 1-10 ARI #140 is 100% wd	2
6	HZP	Groups 1-10 ARI #140 and #117 100% wd	2

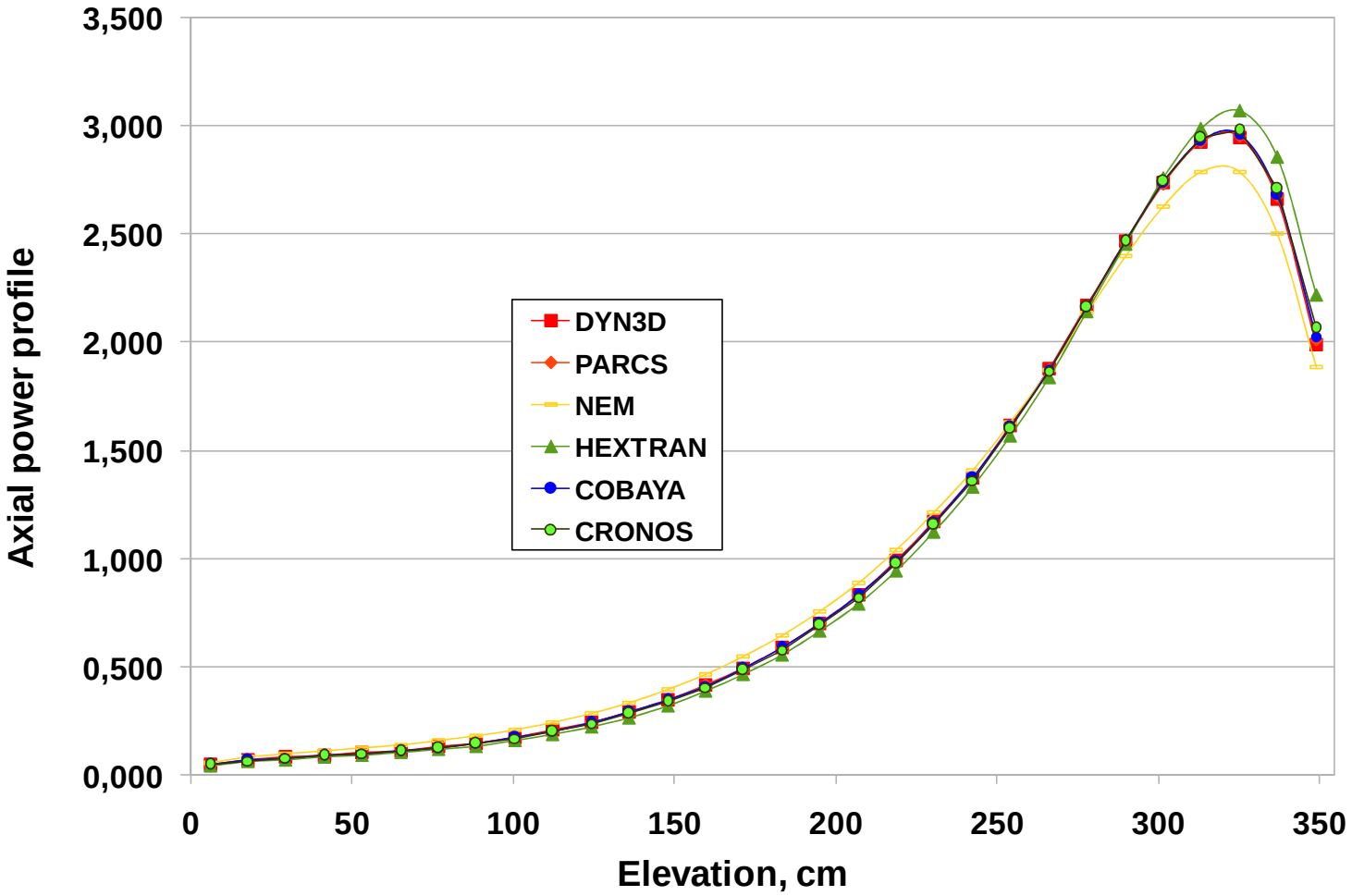
HZP state 0 results

Keff and peaking factors in State 0 (All Rods Out)

Param/Code	DYN3D	COBAYA 6N	Delta
Keff	1.02988	1.03006	-8. E-5
Fxy	1.337	1.339	-0.002
Fz	2.949	2.958	-0.009
AO, %	80.33	80.50	-0.17

NOTE: In this study, the comparison at HZP used the HELIOS generated XS library

HZP State 0 results

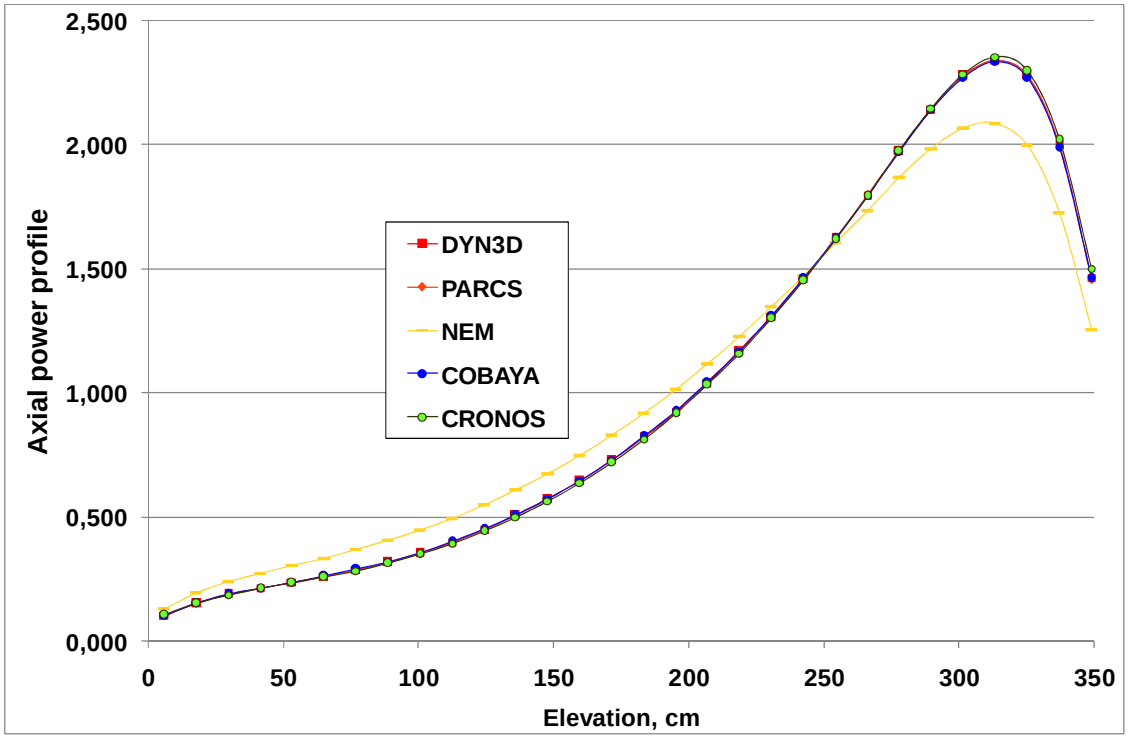


Core averaged axial power distribution

HZP State 1b results

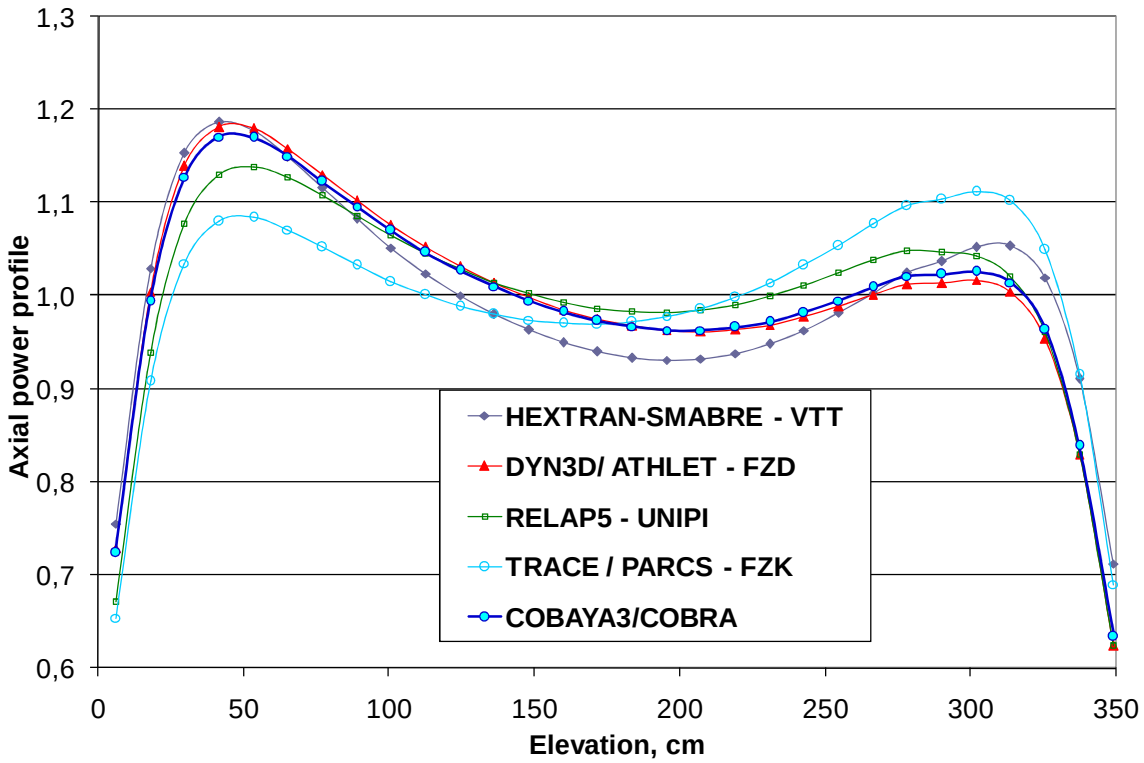
Keff and peaking factors

Param/ Code	DYN3D	COBAYA 6N	DYN-COBAYA
Keff	0.96213	0.96222	-9.E-5
Fxy	1.383	1.388	-0.005
Fz	2.342	2.325	0.017
AO, %	64.1	63.6	-0.5



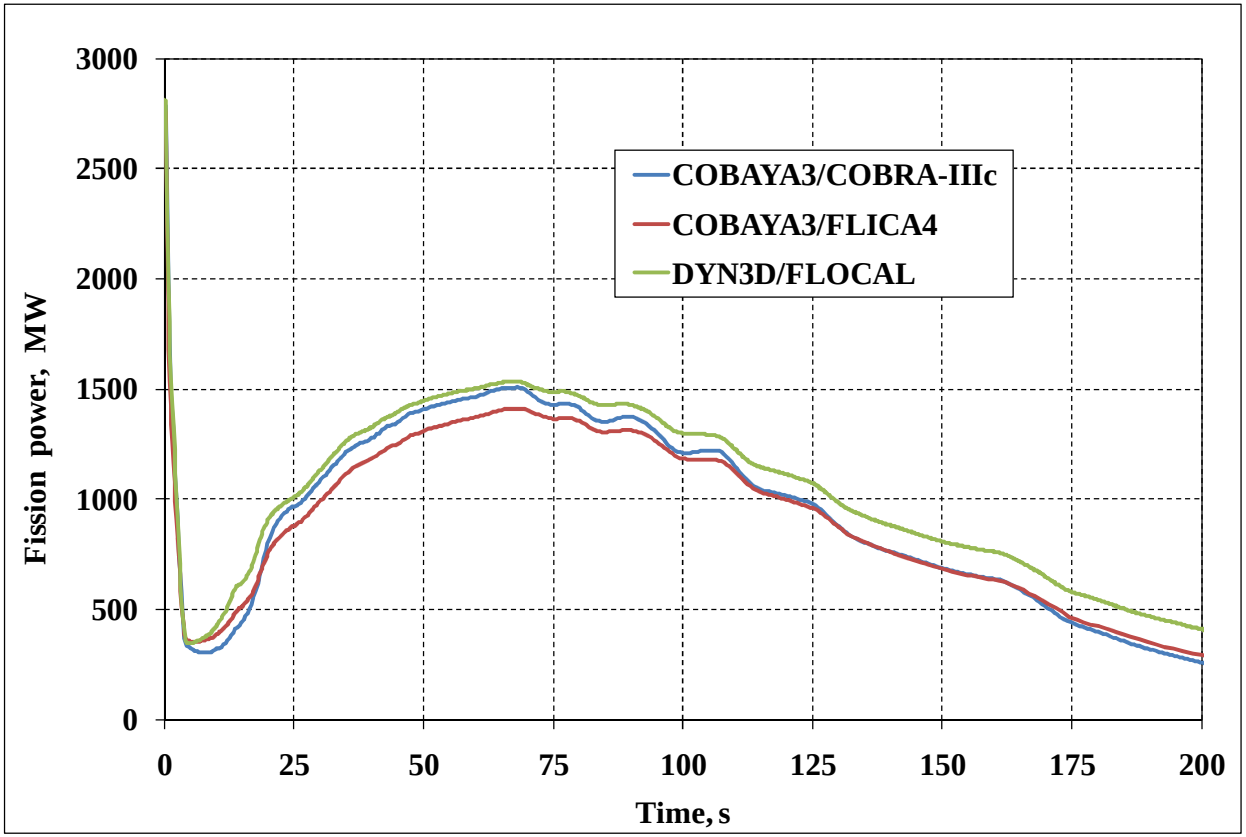
Core averaged axial power distribution

Initial HFP state results



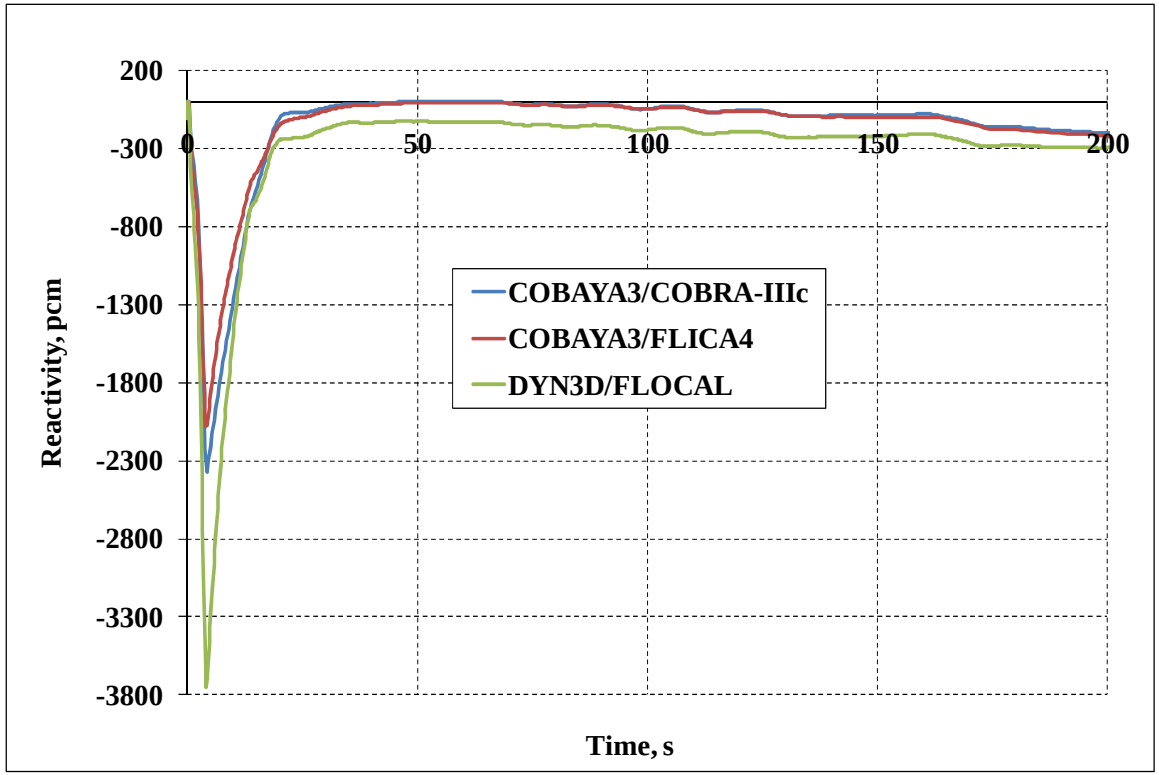
Core average axial power distribution

MSLB transient results



Time history of fission power

MSLB transient results



Time history of total reactivity

Conclusions

- The COBAYA3 and DYN3D HZP results are close to each other
- The COBAYA3/FLICA4 and DYN3D/FLOCAL HFP results are close to each other
- The comparison of transient fission power results shows a max bias of 100 MW, which can be attributed mainly to the differences in TH model (core flow mixing, fuel pin discretization).
- This comparison contributes to the testing of the APOLLO2 generated nodal XS libraries for VVER MSLB analysis
- This comparison contributes to the verification of the COBAYA3/FLICA4 coupling scheme in Salome 5.1.5