NURESAFE WP3.3
Multiscale BWR Thermal-Hydraulics

Status of KIT Contributions to WP3.3

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Outline

- Short review of work done within WP3.3
- Multiscale BWR Thermal-Hydraulics applied to ATWS
- Conclusion & Outlook

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ATHLET-COBRA-TF Coupling script

It can be found in:

https://www-svn-corpus.cea.fr/nuresafe/NURESIM/COUPLING_SCRIPTS

```
# Definition of the environment and libraries to be used

# Ressources of test base
ressourcedir=getenv("NURESAFE_TEST_DATA")

## COBRATF PARAMETERS
CTF_in    = ressourcedir + "/data/cobratf/" + casename + "/" + typecase
CTF_out   = getenv("PWD")
CTF_mesh  = getenv("PWD") + "/COBRATFMESH.med"
CTF_mesh2= getenv("PWD") + "/COBRATFSTRUCTURE.med"
system("ln -sf " + CTF_in + "/" + CTF_file + " deck.inp")
if path.exists(CTF_mesh): remove(CTF_mesh)
if path.exists(CTF_mesh2): remove(CTF_mesh2)

## ATHLET PARAMETERS
ATHLET_in    = ressourcedir + "/data/athlet/" + casename + "/" + typecase
ATHLET_out   = ATHLET_in + "/results"
ATHLET_mesh = getenv("PWD") + "/ATHLETMESH.med"
ATHLET_mesh2= getenv("PWD") + "/ATHLETSTRUCTURE.med"

...........................
```

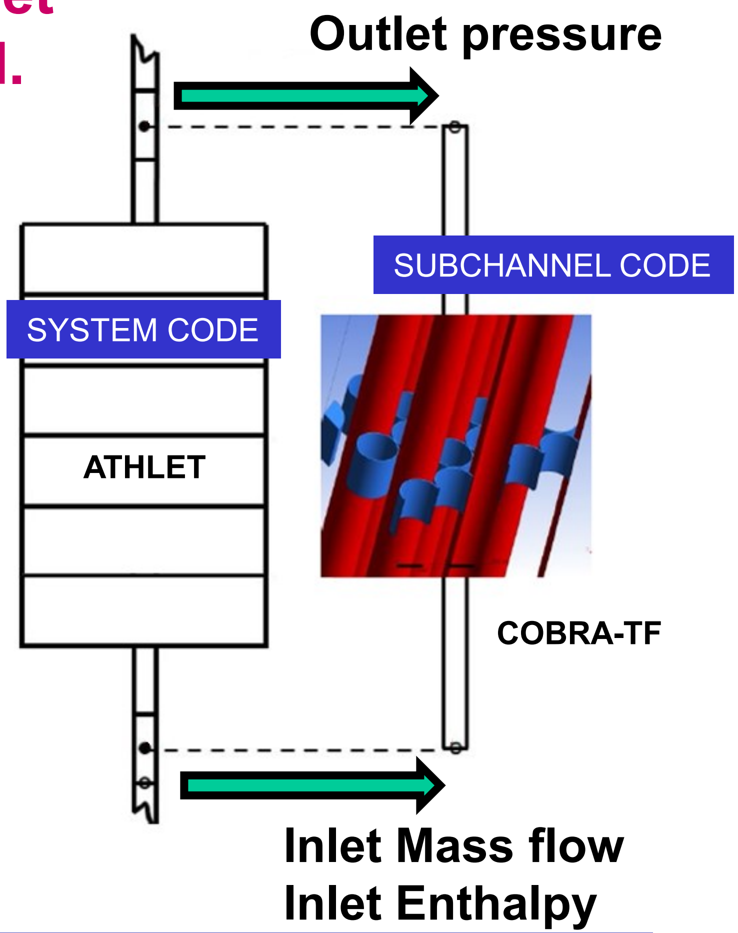
A complete description was done in the last SP3 meeting.

TH/TH coupling

- **A one-way coupling with domain overlapping between ATHLET/COBRA-TF was developed at GRS.**

- **For this coupling at core inlet/outlet 2D Inlet/outlet meshes are created.**
  - getInletMeshCTF
  - getOutletMeshCTF

- **Explicit time coupling**



Summary of recent updates since 6th SP3

- **In the previous meeting, we showed:**
  - Status of contributions to WP3.3 (work done up to June)
  - Description of the ATHLET SALOME component.
  - Description of the COBRA-TF SALOME component.
  - Coupling approach implemented at GRS between ATHLET and COBRA-TF
  - Testing of ATHLET/COBRA-TF system in a minicore configuration.
- **In the last three months, the ATHLE/COBRA-TF coupled codes were used at KIT for the Oskarshamn-2 ATWS event.**
- **Interaction with GRS was fluent and constructive, so all the minor difficulties were solved on the way.**

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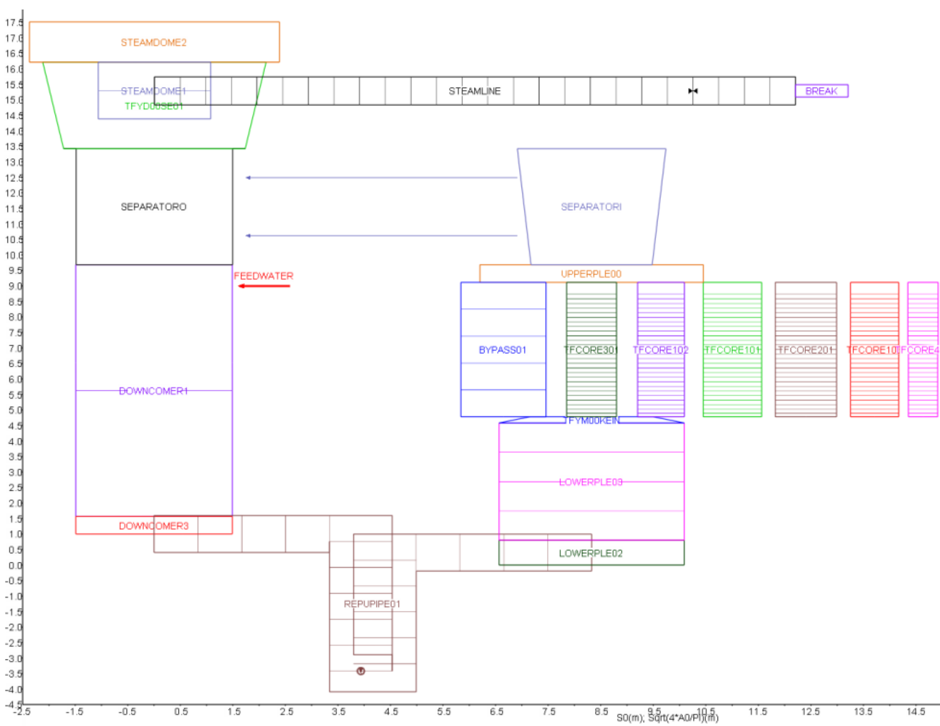
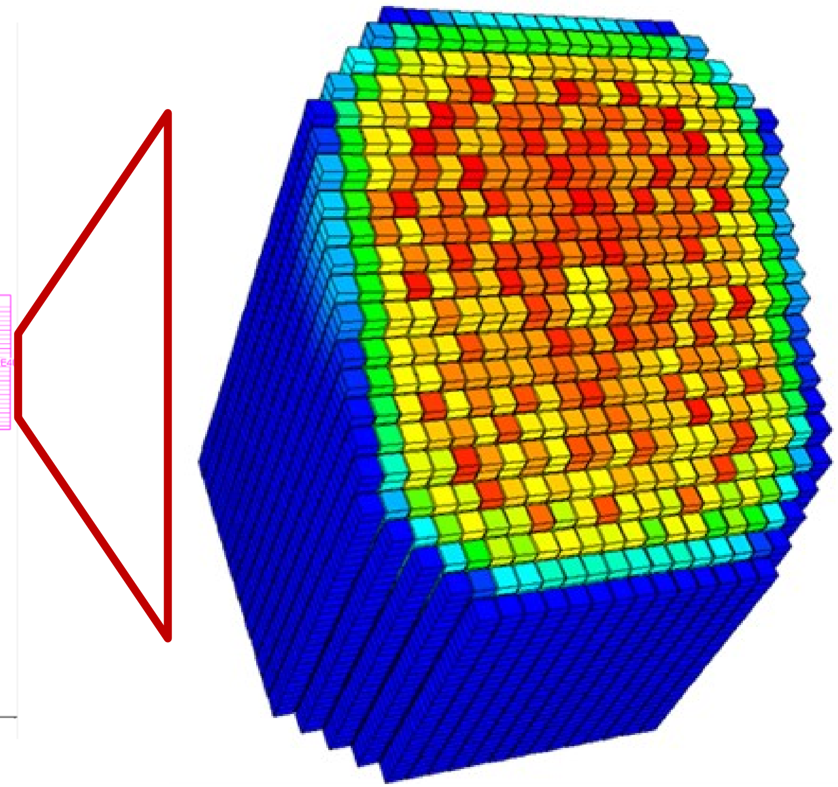
Scope of the multiscale coupling within WP3.3

- **ATHLET with a coarse core model and CTF full core assembly-wise**
  - ATHLET using 6 channel model of the O2 core
  - COBRA-TF using 444 channel model of the O2 core



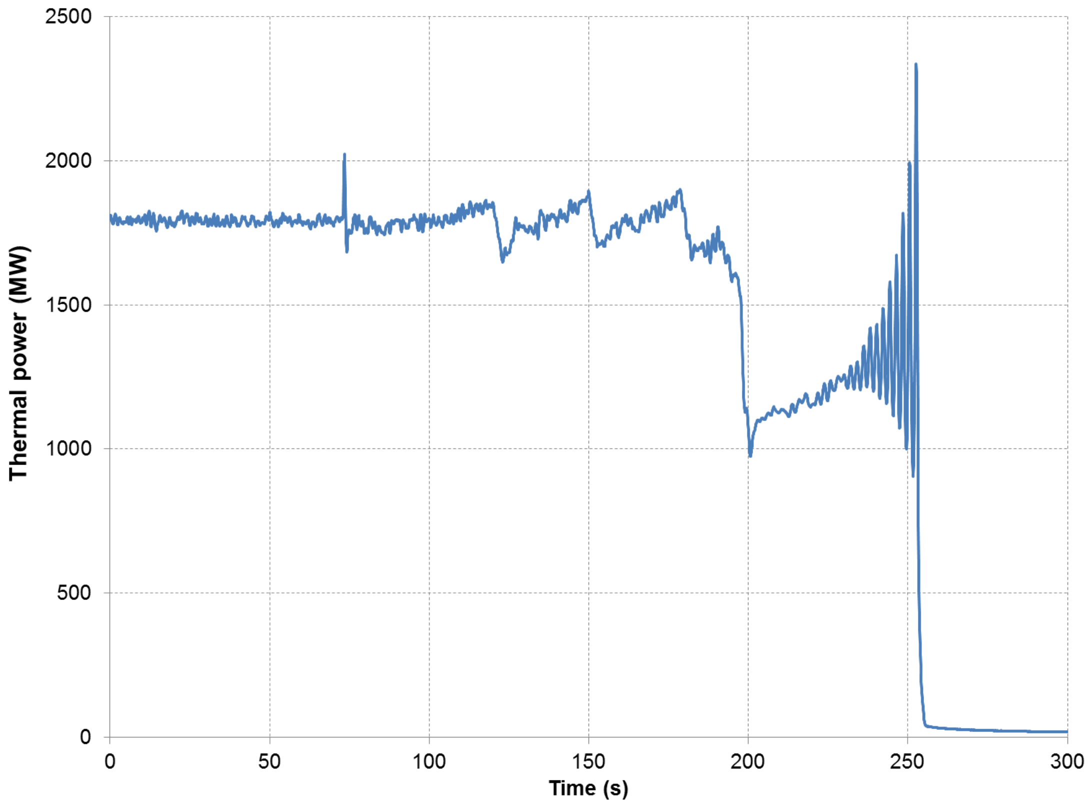
ATHLET



COBRA-TF

ATHLET/COBRA-TF for BWR ATWS

- **The Oskarshamn-2 feedwater transient has been computed using the most accurate 3D power distribution available.**
  - A 3D power distribution coming from a coupled TRACE/PARCS using 444 parallel channels (1 per FA).



ATHLET/COBRA-TF for BWR ATWS

- **Radial power distribution imposed in COBRA-TF.**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1					0.1966	0.2342	0.2744	0.2937	0.3162	0.3068	0.3101	0.3129	0.3146	0.3052	0.3038	0.2819	0.2426	0.1983				
2				0.2766	0.3866	0.4672	0.5023	0.5447	0.5685	0.5548	0.5629	0.5713	0.5729	0.5742	0.5740	0.5224	0.4802	0.3849	0.2761			
3			0.3186	0.4621	0.7549	0.8995	0.8139	1.0392	1.0334	0.8767	1.0546	1.0131	1.0044	1.0715	1.0572	0.9302	0.9274	0.7474	0.4612	0.3302		
4		0.2825	0.4709	0.8128	1.0333	0.9651	1.2122	1.3493	1.0188	1.2375	1.0989	1.4017	1.2738	1.0024	1.3436	1.0100	0.9662	1.0469	0.8238	0.4769	0.2905	
5	0.2062	0.4024	0.7694	1.0383	0.9540	1.4205	1.3249	1.1210	1.3502	1.2950	1.3777	1.1287	1.2535	1.3477	1.1410	1.3310	1.4342	0.9813	1.0632	0.7853	0.4080	0.2072
6	0.2563	0.4845	0.9386	0.9249	1.4205	1.3694	1.1397	1.1708	1.3125	1.6084	1.2345	1.4669	1.6069	1.1548	1.3954	1.1959	1.4082	1.4571	0.9462	0.9428	0.5018	0.2529
7	0.2904	0.5434	0.9337	1.1648	1.3382	1.1374	1.5362	1.2264	1.2469	1.2983	1.5338	1.3520	1.2986	1.2357	1.2443	1.5853	1.2296	1.3714	1.2572	0.9658	0.5334	0.2894
8	0.3102	0.5908	1.0717	1.3786	1.1533	1.4036	1.1663	1.5737	1.2485	1.2856	1.3187	1.7341	1.5286	1.2497	1.6086	1.2297	1.4201	1.0704	1.3804	1.0842	0.5428	0.3001
9	0.3125	0.5766	1.0813	1.0352	1.3653	1.3045	1.4371	1.0890	1.2859	1.3439	1.5079	1.3409	1.4614	1.3981	1.2904	1.3146	1.3336	1.3715	1.0431	0.9865	0.5718	0.3096
10	0.3144	0.5604	0.9751	1.2879	1.1747	1.5745	1.2183	1.4737	1.4295	1.6429	1.2674	1.4640	1.6613	1.3000	1.2799	1.2557	1.5478	1.1484	1.2265	0.9940	0.5712	0.3042
11	0.3198	0.5918	0.9822	1.3696	1.0583	1.3998	1.2292	1.6385	1.3420	1.4593	0.9599	0.9270	1.2694	1.5029	1.2433	1.2095	1.1660	1.3185	1.0811	1.0648	0.5903	0.3188
12	0.3172	0.5889	1.0639	1.0798	1.3180	1.1653	1.2090	1.2405	1.5041	1.2729	0.9277	0.9598	1.4582	1.3252	1.6387	1.2297	1.4003	1.0590	1.3696	0.9825	0.5928	0.3216
13	0.3022	0.5695	0.9932	1.2259	1.1478	1.5470	1.2553	1.2790	1.3001	1.6626	1.4657	1.2706	1.6450	1.4305	1.4760	1.2199	1.5763	1.1763	1.2867	0.9743	0.5609	0.3158
14	0.3073	0.5682	0.9856	1.0422	1.3711	1.3336	1.3137	1.2863	1.3977	1.4622	1.3420	1.5109	1.3474	1.3058	1.0929	1.4407	1.3084	1.3663	1.0232	1.0804	0.5775	0.3137
15	0.2976	0.5408	1.0826	1.3789	1.0701	1.4193	1.2281	1.6065	1.2481	1.5289	1.7355	1.3230	1.2914	1.2534	1.5804	1.1709	1.4067	1.1542	1.3791	1.0716	0.5900	0.3118
16	0.2862	0.5305	0.9637	1.2553	1.3703	1.2258	1.5825	1.2420	1.2333	1.2976	1.3515	1.5362	1.3021	1.2528	1.2347	1.5406	1.1406	1.3415	1.1666	0.9352	0.5445	0.2917
17	0.2484	0.4911	0.9395	0.9443	1.4546	1.4055	1.1938	1.3932	1.1542	1.6028	1.4653	1.2372	1.6106	1.3147	1.1734	1.1414	1.3720	1.4234	0.9384	0.9414	0.4862	0.2575
18	0.2027	0.4050	0.7824	1.0613	0.9794	1.4315	1.3290	1.1383	1.3434	1.2360	1.1239	1.3769	1.2948	1.3513	1.1221	1.3266	1.4221	0.9547	1.0406	0.7712	0.4059	0.2072
19		0.2879	0.4723	0.8218	1.0454	0.9643	1.0078	1.3397	0.9971	1.2692	1.3974	1.0985	1.2369	1.0188	1.3496	1.2117	0.9653	1.0336	0.8128	0.4740	0.2875	
20			0.3276	0.4603	0.7461	0.9266	0.9288	1.0548	1.0680	1.0008	1.0097	1.0525	0.8763	1.0325	1.0387	0.8136	0.8987	0.7541	0.4646	0.3198		
21				0.2751	0.3885	0.4788	0.5208	0.5714	0.5715	0.5703	0.5688	0.5613	0.5536	0.5671	0.5439	0.5016	0.4670	0.3887	0.2820			
22					0.1992	0.2416	0.2801	0.3013	0.3026	0.3120	0.3104	0.3087	0.3047	0.3104	0.2922	0.2734	0.2333	0.1972				

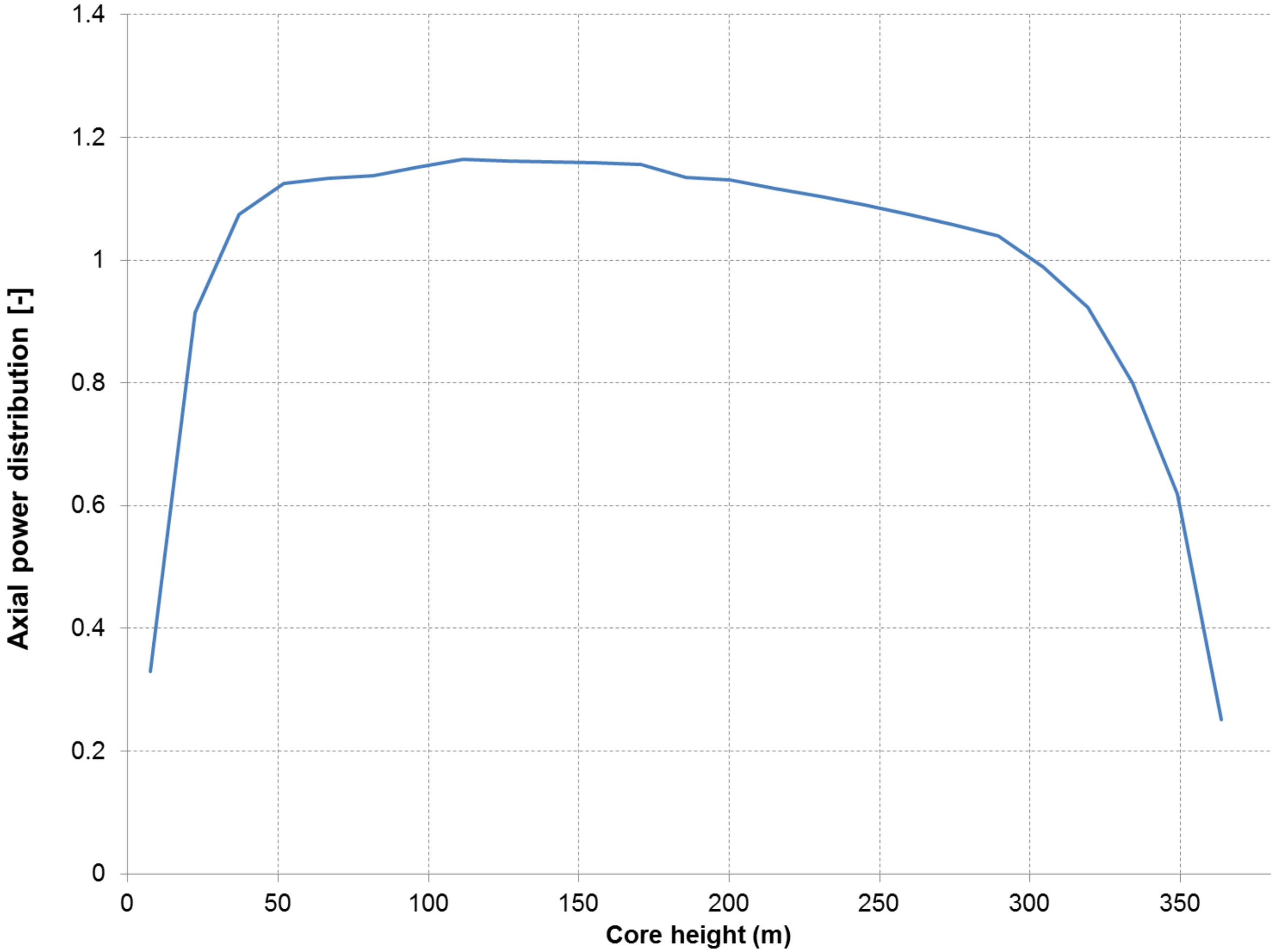
ATHLET/COBRA-TF for BWR ATWS

- **Radial power distribution imposed in ATHLET.**

				6	6	6	6	6	6	6	6	6	6	6	6	6	6				
			6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6			
		6	5	1	3	1	2	2	1	2	2	2	2	2	1	2	1	5	6		
	6	5	2	2	1	3	4	1	3	1	4	3	1	4	1	1	2	2	5	6	
6	5	2	2	1	4	2	1	3	2	3	1	1	3	1	3	4	1	2	2	5	6
6	5	2	1	4	3	1	1	2	3	1	3	3	1	2	1	3	4	1	3	5	6
6	5	1	2	3	1	4	2	2	2	2	2	2	1	1	3	1	2	3	2	5	6
6	5	4	4	1	3	1	3	2	2	2	3	3	1	3	1	3	1	4	2	5	6
6	5	4	1	3	2	3	1	1	1	3	2	2	2	2	2	2	2	1	2	5	6
6	5	1	2	1	3	1	3	2	3	2	2	3	3	2	2	3	1	3	2	5	6
6	5	1	4	1	3	1	3	3	2	2	2	2	2	1	1	1	3	1	2	5	6
6	5	2	1	3	1	1	1	2	2	2	2	2	3	3	1	3	1	4	1	5	6
6	5	2	3	1	3	2	2	3	3	2	2	3	2	3	1	3	1	2	1	5	6
6	5	2	1	2	2	2	2	2	2	2	3	1	1	1	3	2	3	1	4	5	6
6	5	2	4	1	3	1	3	1	3	3	2	2	2	3	1	3	1	4	4	5	6
6	5	2	3	2	1	3	1	1	2	2	2	2	2	2	4	1	3	2	1	5	6
6	5	3	1	4	3	1	2	1	3	3	1	3	2	1	1	3	4	1	2	5	6
6	5	2	2	1	4	3	1	3	1	1	3	2	3	1	2	4	1	2	2	5	6
	6	5	2	2	1	1	4	1	3	4	1	3	1	4	3	1	2	2	5	6	
		6	5	1	2	1	2	2	2	2	2	1	2	2	1	3	1	5	6		
			6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6			
				6	6	6	6	6	6	6	6	6	6	6	6	6	6				

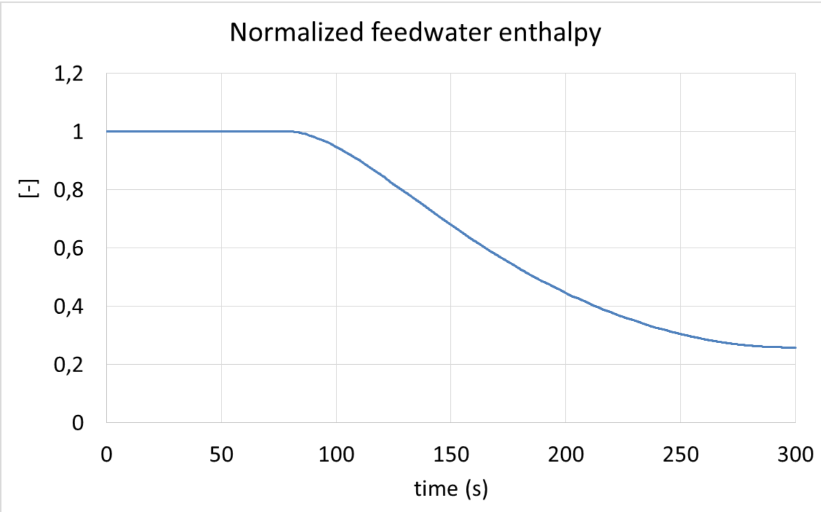
Channel TFCORE	101	201	301	401	102	103
# of channels	100	64	68	112	74	26
Position	1	5	6	2	3	4
Type of FA (Figure 29)	1	1	1	2	3	4
Radial power	1.1150	0.5308	0.2904	1.2103	1.4474	1.3890
# of pins per FA	64	64	64	72	72	91

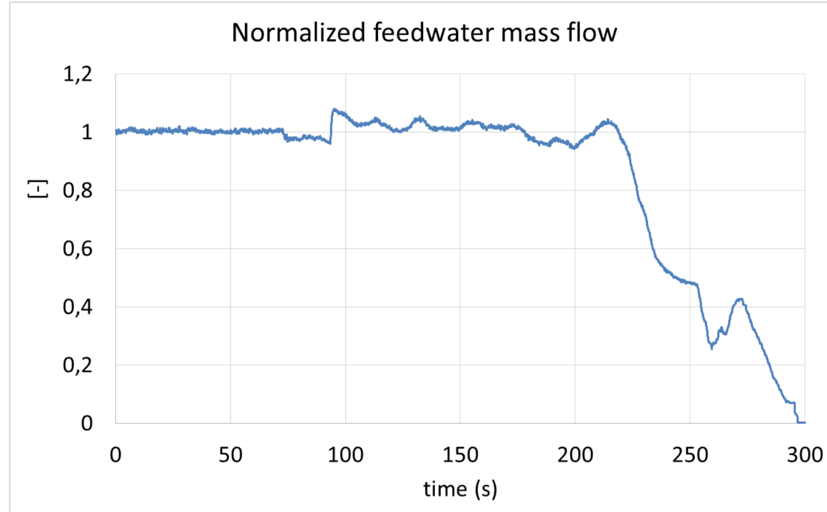
- **Axial power distribution imposed in COBRA-TF and ATHLET**

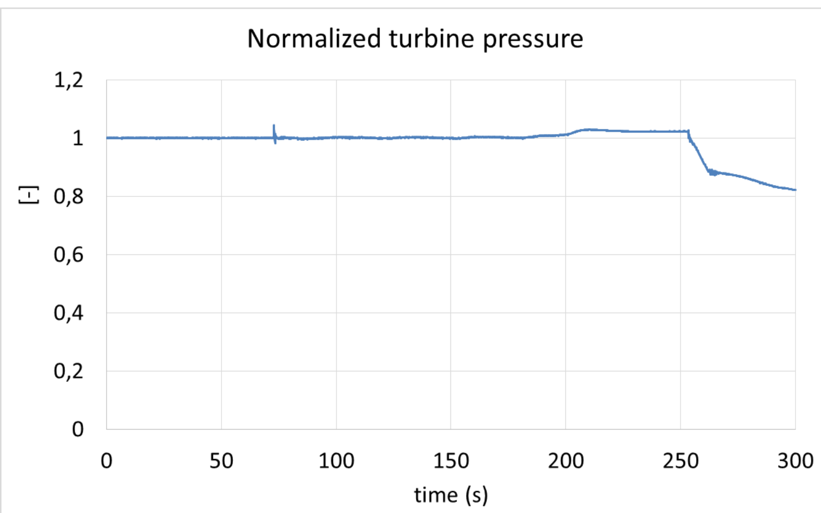


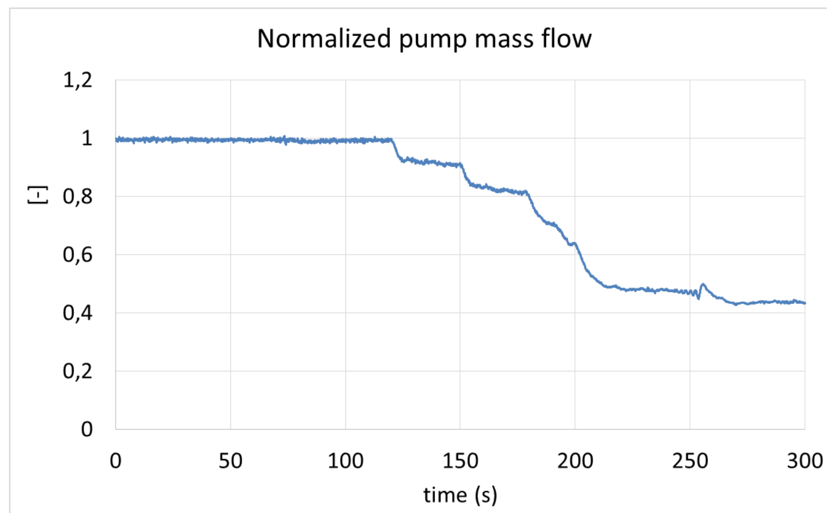
ATHLET/COBRA-TF for BWR ATWS

- **Transient boundary conditions imposed in ATHLET**



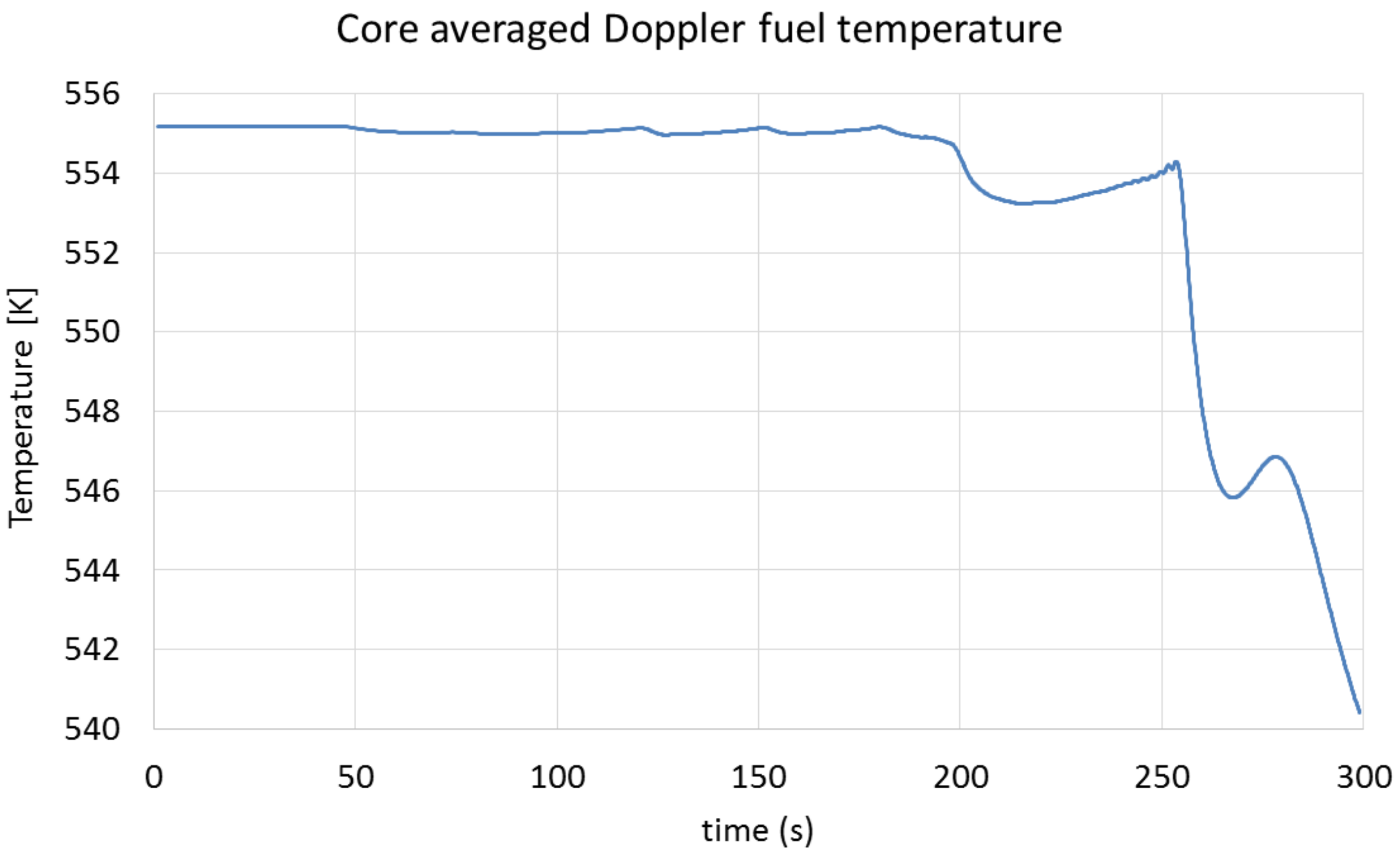






Results of ATHLET/COBRA-TF

- **COBRA-TF core average results:**



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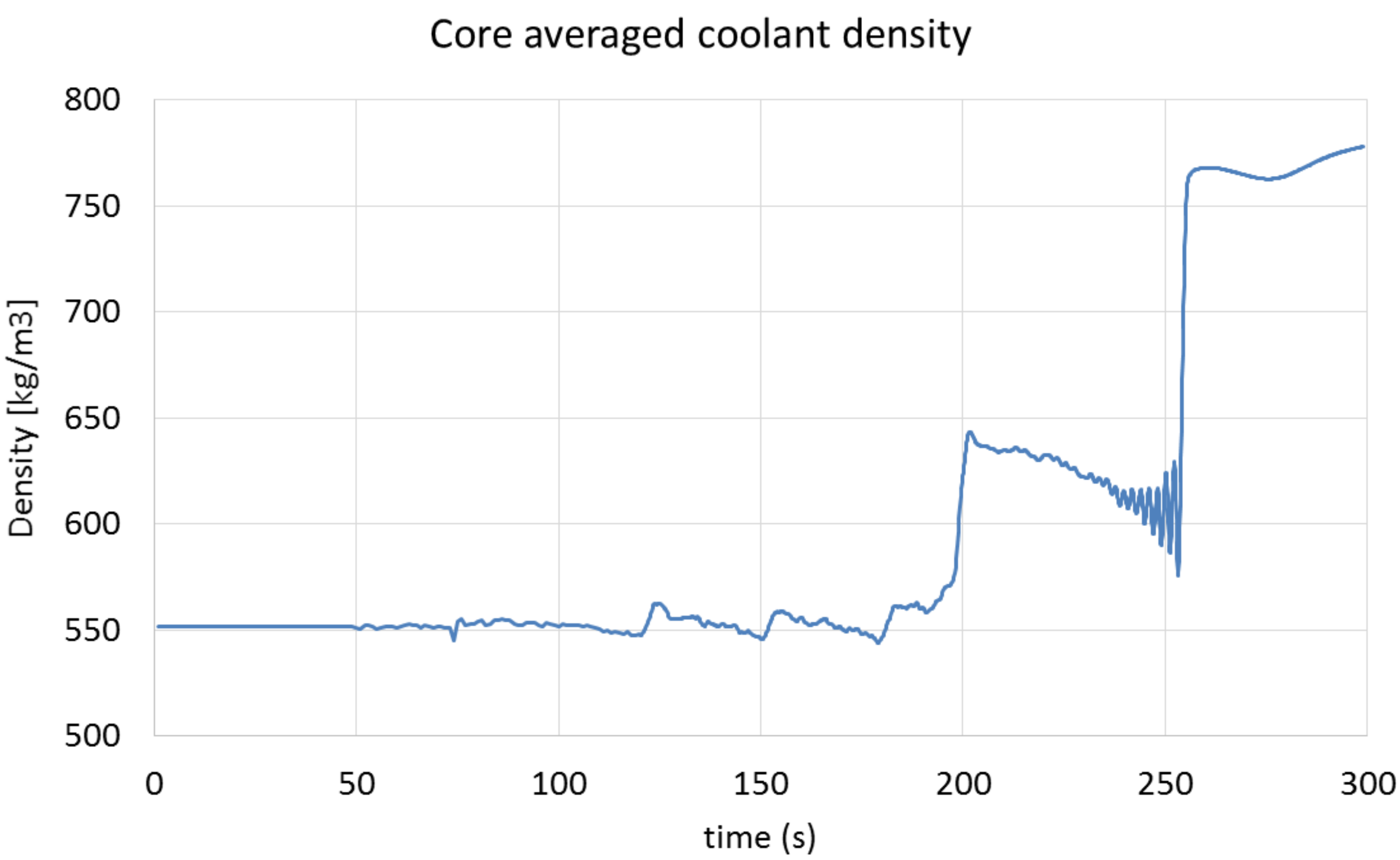

Results of ATHLET/COBRA-TF

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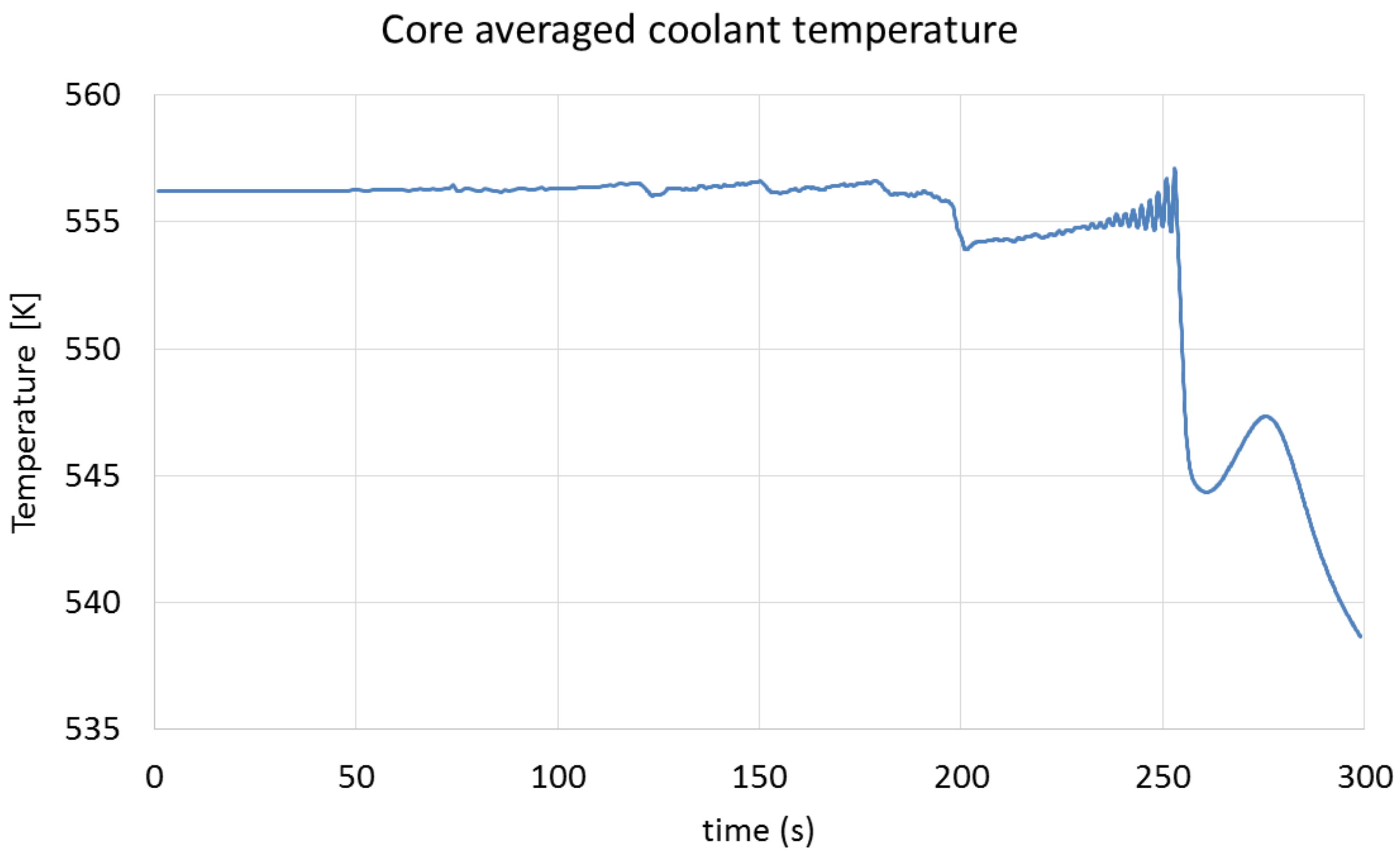
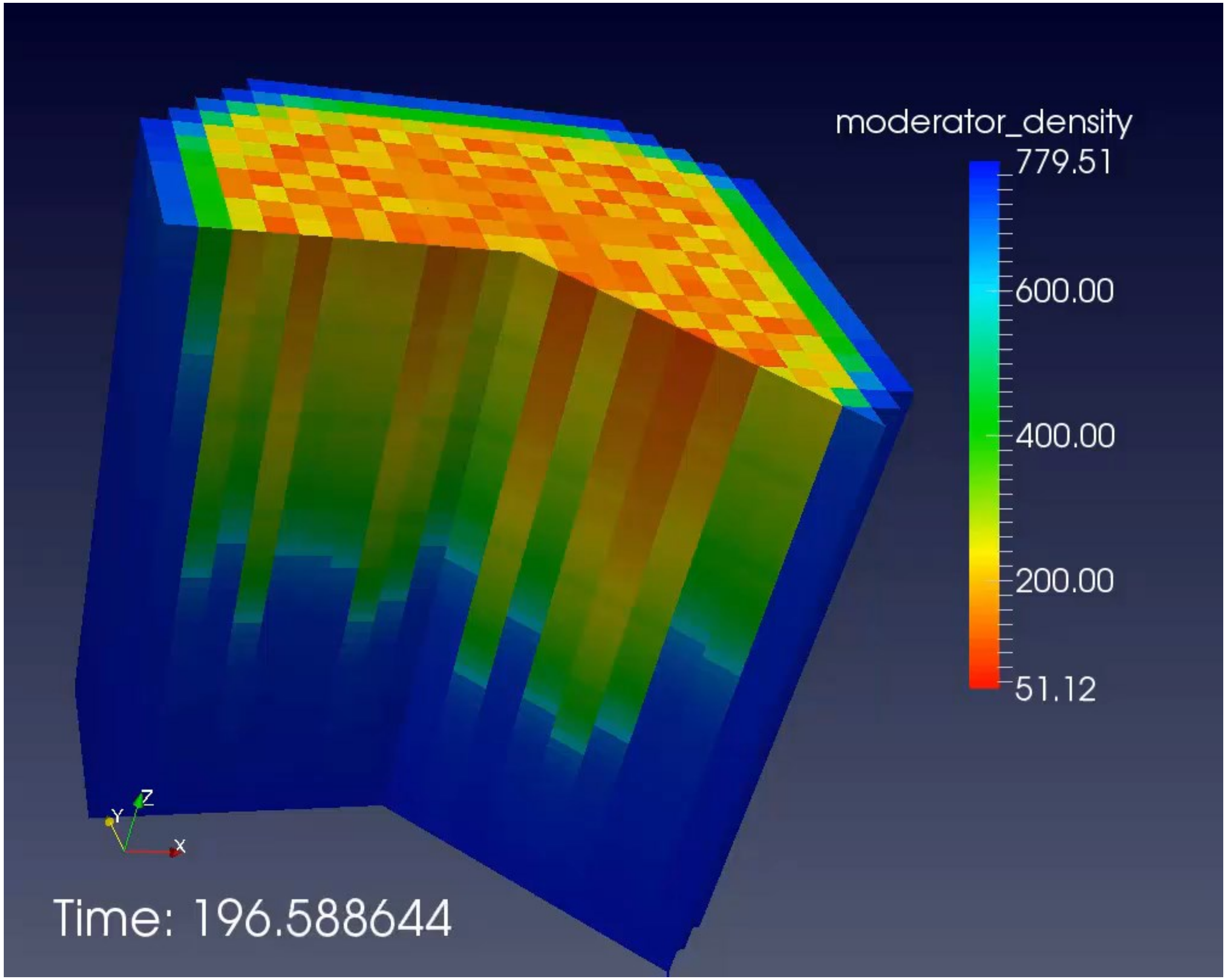
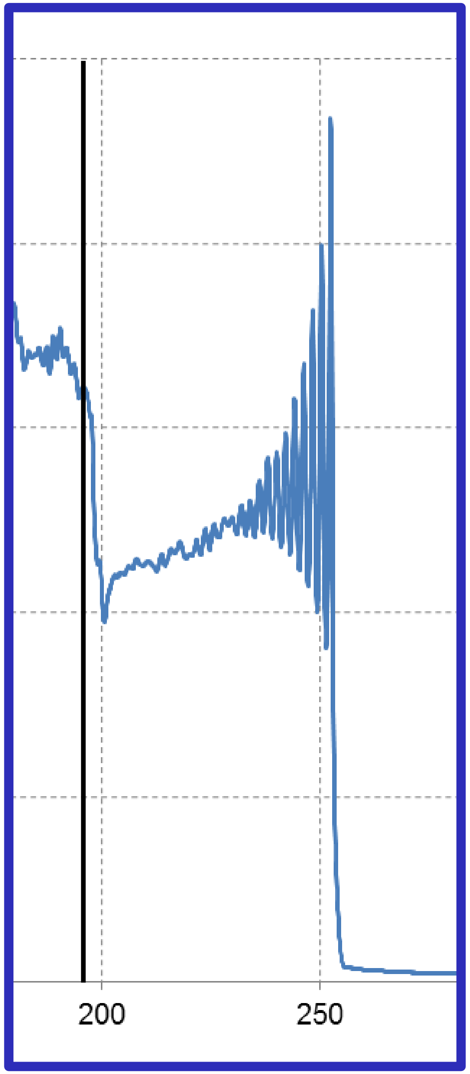


- **COBRA-TF 3D coolant density**



Power vs. time



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Conclusion & Outlook

- **Conclusions:**
  - Multiscale TH simulations could be performed using the system ATHLET/COBRA-TF developed at GRS.
  - Application to the Oskarshamn-2 feedwater transient event has been succesfully conducted.

- **Outlook in the next months:**
  - Complete analysis of the Multi-scale BWR simulations performed.
    - Comparison against plant data available within the O2 benchmark will follow.
  - Submission of the D33.12.5 final version (complete draft already available).
    - D33.12.5 Report about multi-scale simulation of a BWR ATWS transient.