AGENZIA NAZIONALE
PER LE NUOVE TECNOLOGIE, L'ENERGIA
E LO SVILUPPO ECONOMICO SOSTENIBILE

PHEBUS FPT3 and MELCOR 1.8.6

Sensitivity Analysis Focusing on Core Degradation Using Available Data From PHEBUS FPT3

Felice de Rosa - Marco Sangiorgi
ENEA MMS BOLOGNA

2nd EMUG meeting
Prague 1-2 March 2010

Background

Concerning Severe Accidents, ENEA is active partner in:

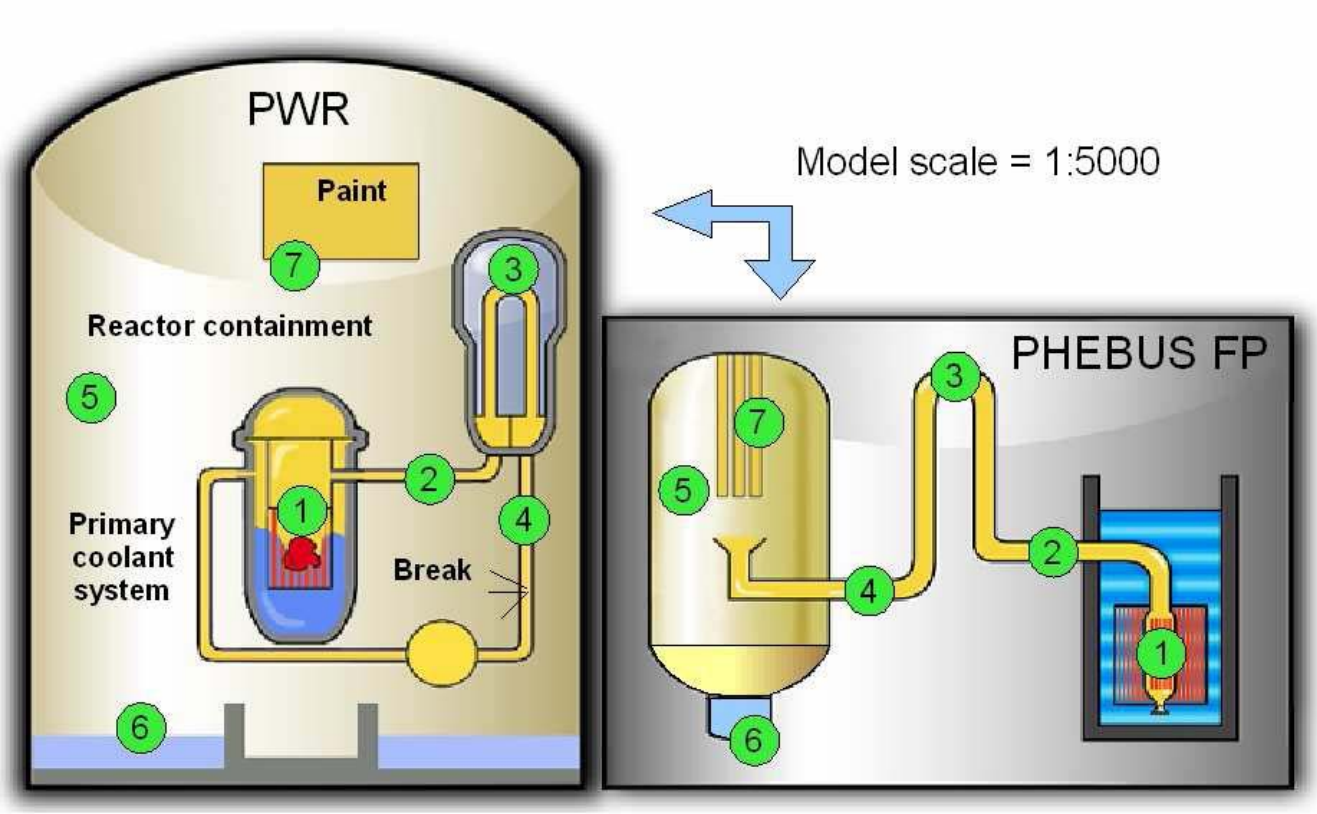
- **SARNET2** Project (Severe Accident Research Network of Excellence, 7th EURATOM Framework Programme).
- **CSARP** (Cooperative Severe Accident Research Programme) and **MCAP** (Melcor Code Assessment Programme).
- **EMUG** (European Melcor Users' Group).
- **BIC** (Bundle), **CACIC** (Circuit and Containment), **CCIC** (Containment Chemistry) PHEBUS Interpretation Circles.
- OECD/CSNI/**WGAMA** (Working Group on Analysis and Management of Accidents).

Recent Works

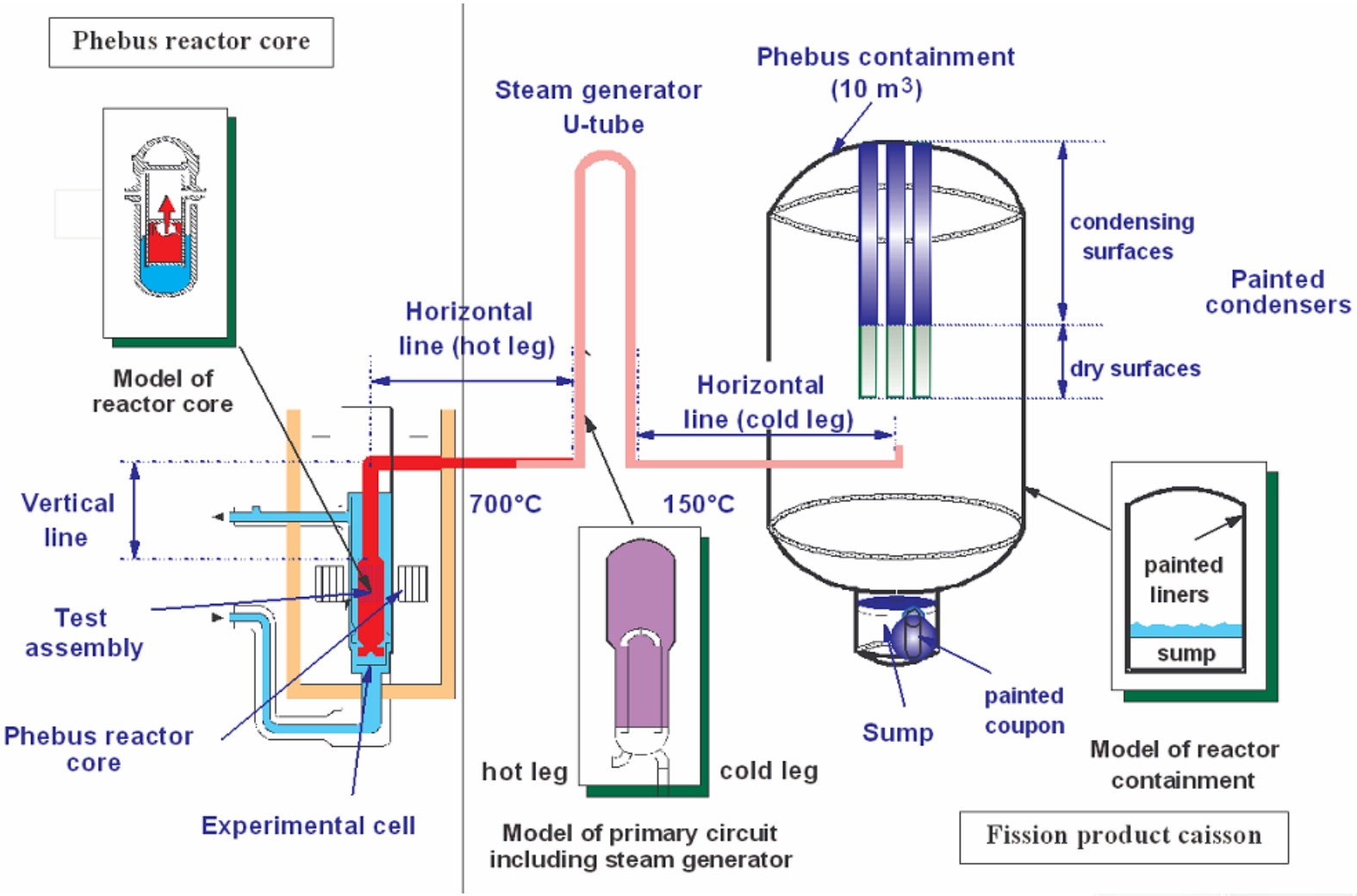
- «*Progress of ASTEC Code Validation on Circuit Thermal-hydraulics And Core Degradation*», *presented* at the last **ERMSAR** meeting (SARNET European Review Meeting on Severe Accidents), held on 23-25 September 2008 at Nesseber (Bulgaria).
- «LFW-SG Accident Sequence in a PWR 900: Considerations Concerning Recent MELCOR 1.8.5 / 1.8.6 Calculations», presented at the 1st **EMUG** Meeting, held in Villigen, Switzerland on 15-16 December 2008.
- «Recent Enea Activities in The Field of Severe Accidents And Computer Code Calculations», presented at the **CSARP** Meeting, held in Bethesda, MA, on 15-17 September, 2009.

Relevance of PHEBUS FP

In terms of fission products, the Phebus-FP facility is scaled down by a factor 5000 relative to a 900-MWe PWR: the scale factor uniformly applies to the initial bundle inventory, the circuit concentrations and the containment concentrations, so as to ensure that representative phenomena can be studied under typical concentrations.



General Description of PHEBUS FP



PHEBUS FP and Severe Accident Analysis

According to the statements reported in the previous slides, a good way to learn more about severe accidents is to refer to **PHEBUS FP** experiments.

The general objective of the Phebus FP programme is to investigate the main phenomena involved in postulated severe accidents that could occur in a Light Water Reactor (LWR).

These accidents include:

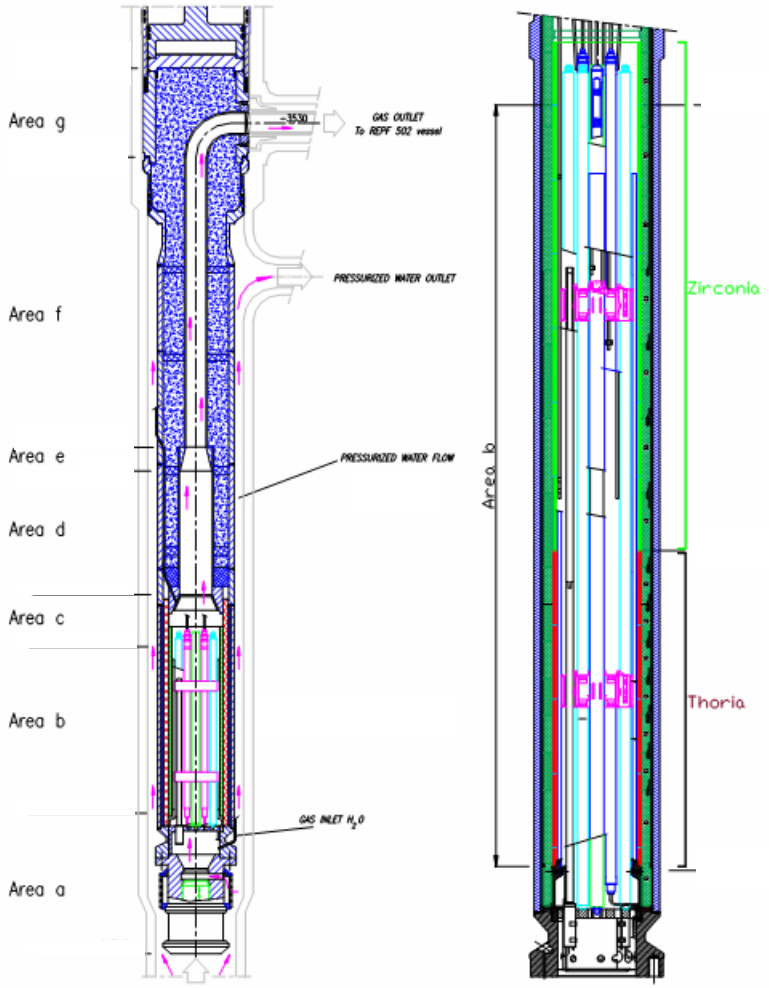
- **Irradiated-fuel degradation**, with prototypic material, under steam-rich or steam-poor conditions.
- Fission product (FP), fuel, control rod and structure **material release** from the test bundle.
- Released material **transport and deposition** in the Reactor Coolant System.
- FP and aerosol **behaviour in the containment building**, with major attention to Iodine.

ENEA work in WP8.3 of SARNET2

In the ambit of the WP8.3 *"Bringing research results into reactor applications"* ENEA takes part in one of the proposed benchmarks using **ASTEC** and **MELCOR** codes and performing calculations taking account of **PHEBUS FPT3** test (work still in progress)

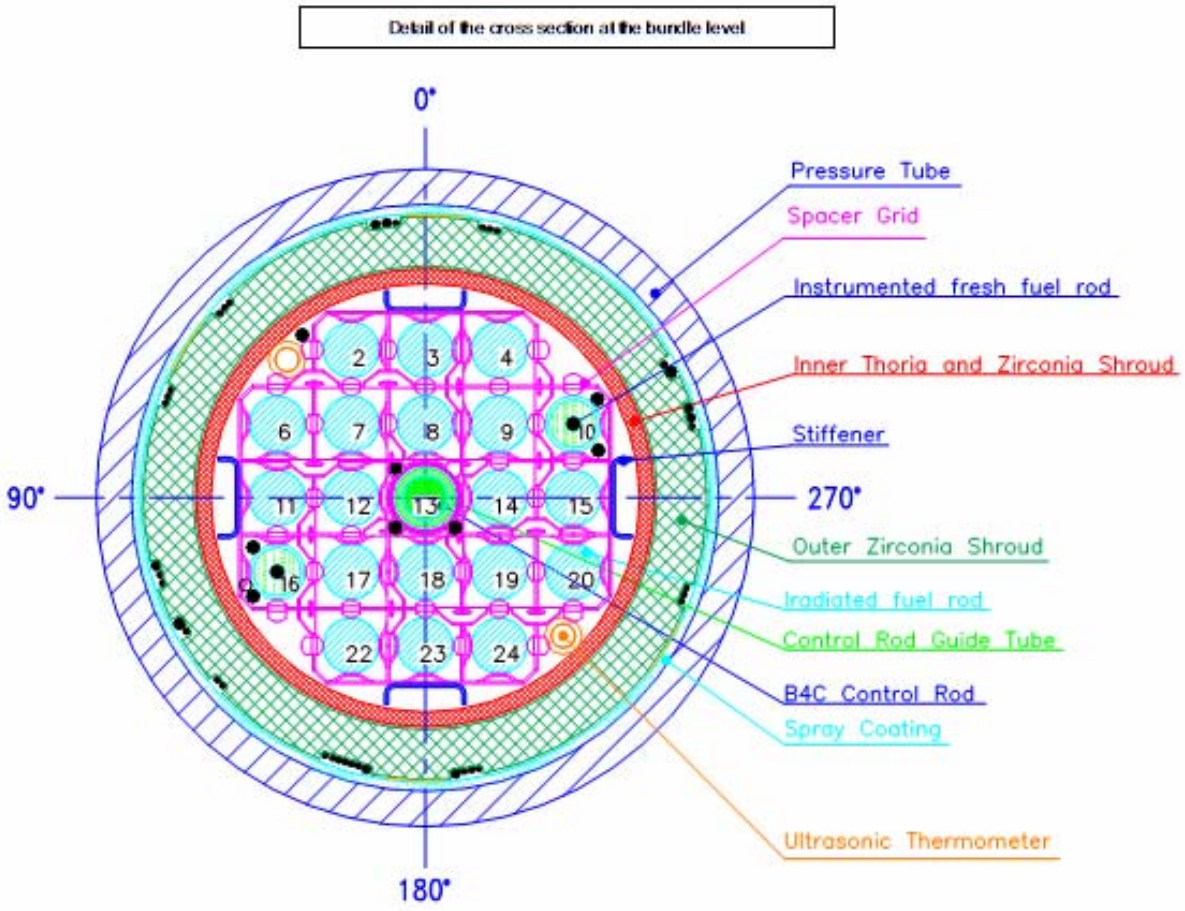
HERE IT IS AN ADVANCE OF THE WORK

FPT3 test device

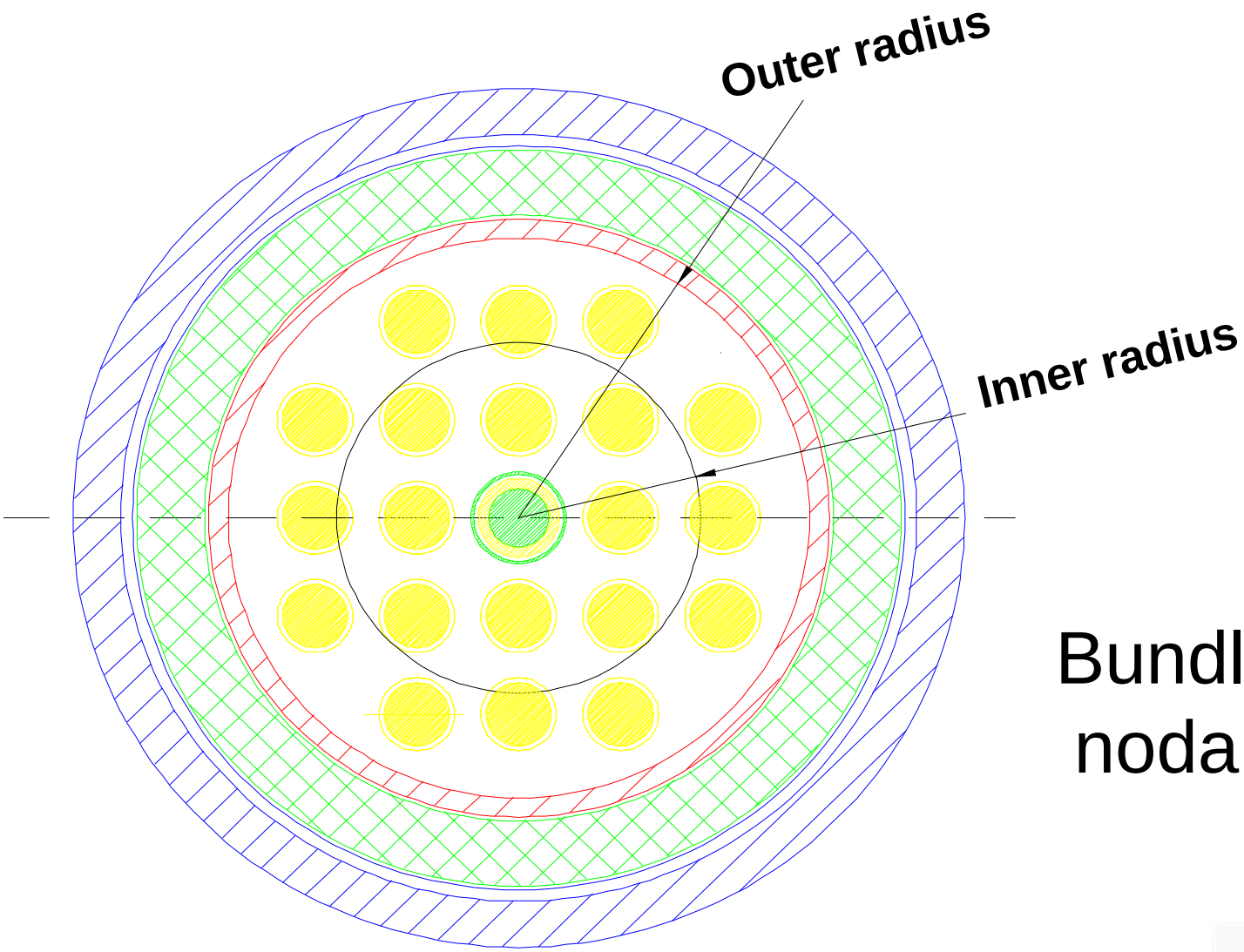


Schematic of the FPT3 test device

Cross section details

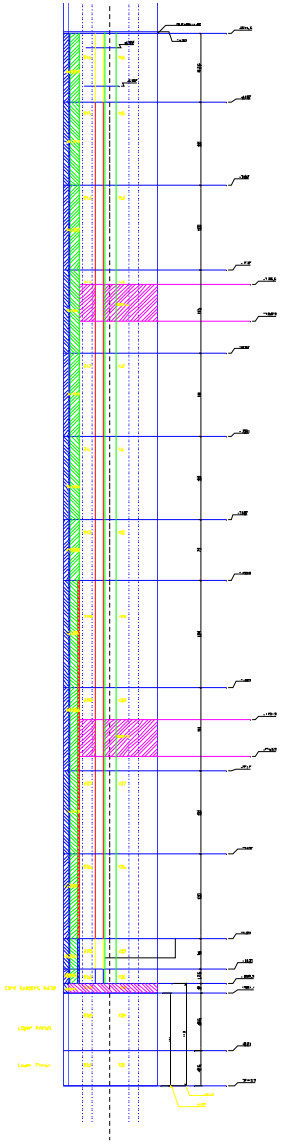


CORE nodalization



Bundle radial nodalization

CORE nodalization



Bundle axial nodalization

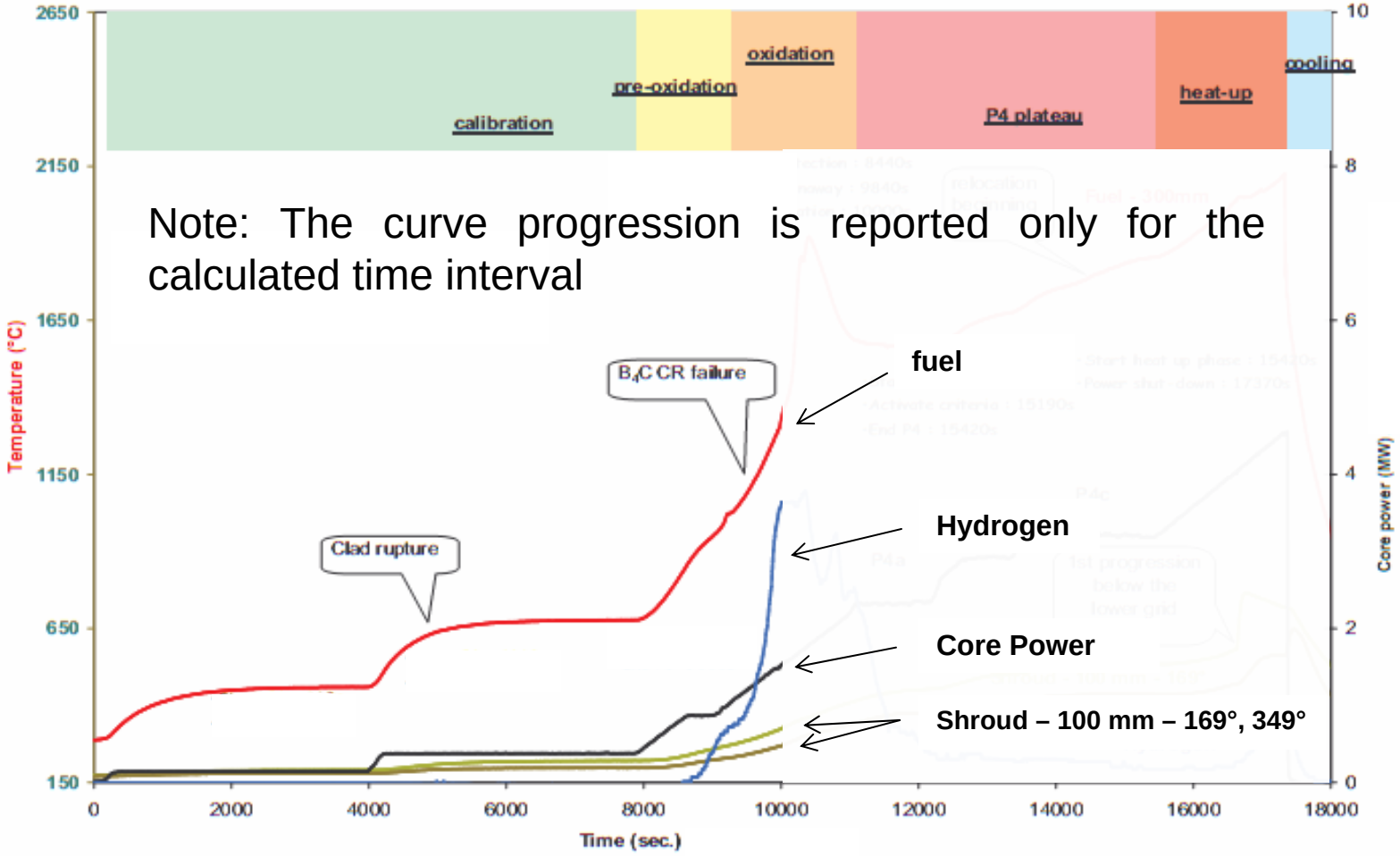
16 axial levels of which:

- 3 in the lower head (including Core Support Plate)
- 2 with no active fuel
- 2 with spacers

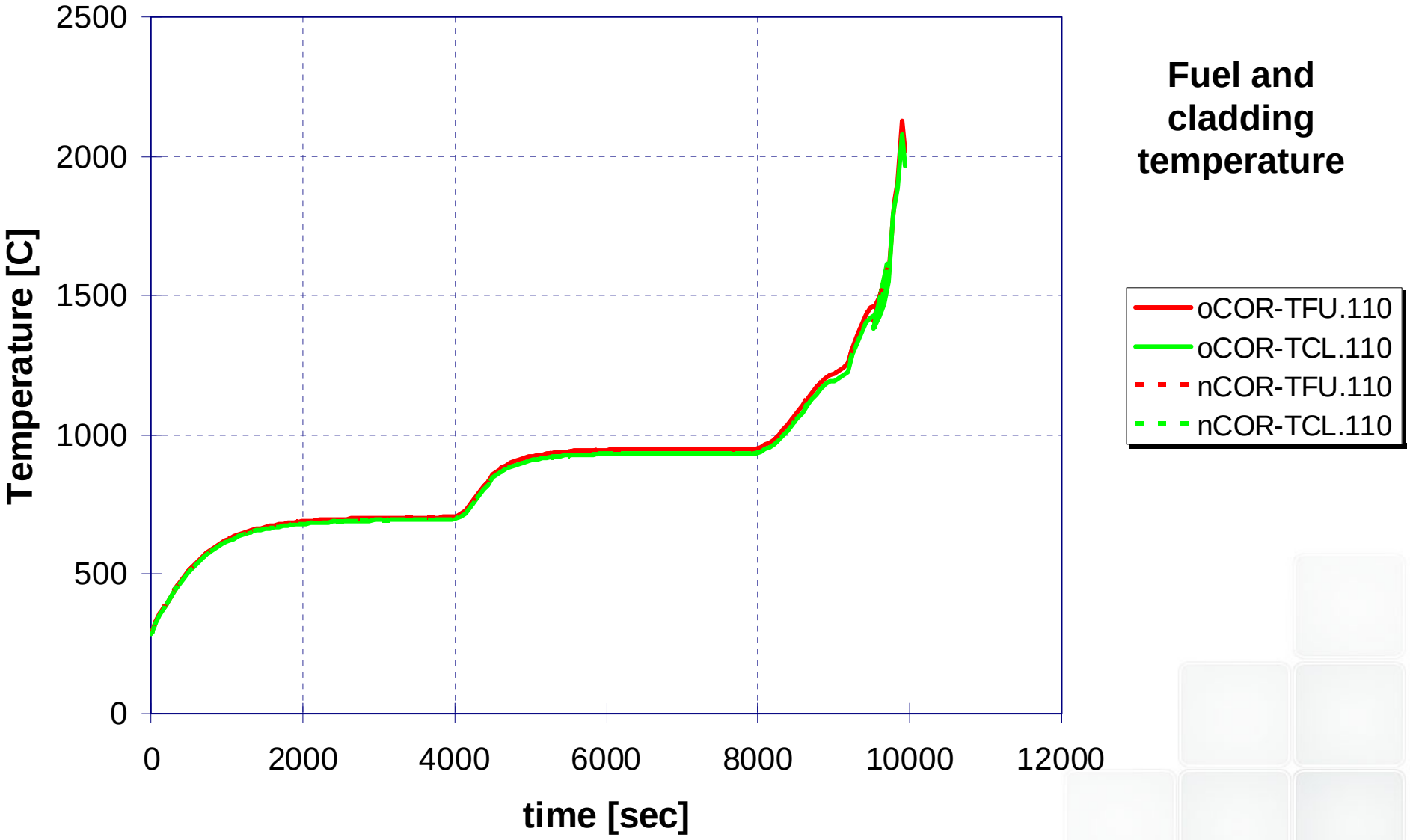
FPT3 Importance

- A strong difference between FPT3 and previous tests is the use of a B_4C control rod instead of a AgInCd control rod (Silver-Indium-Cadmium).
- It will be possible to properly test the MELCOR New Model for Release and Oxidation of B_4C Control Poison.

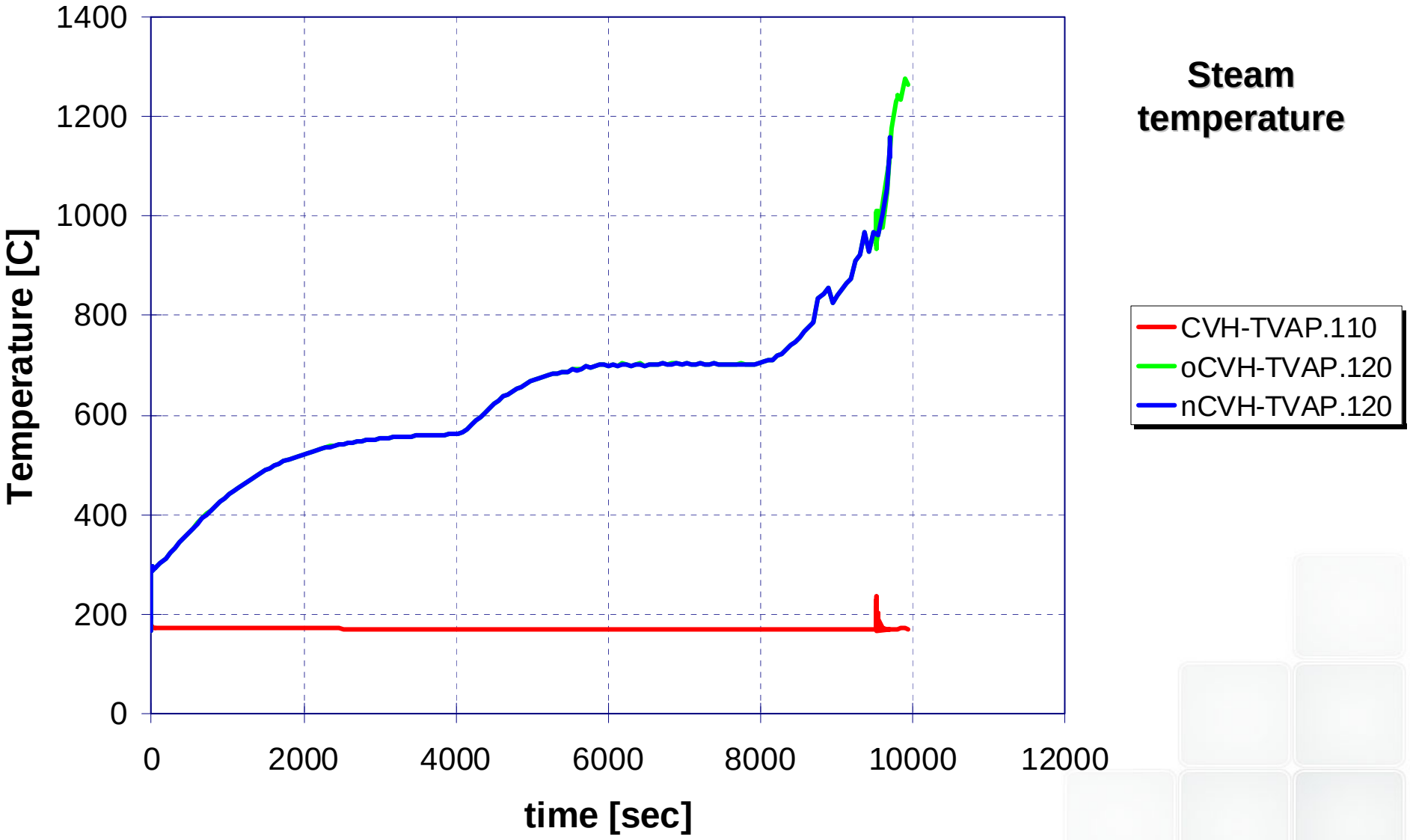
Degradation phase



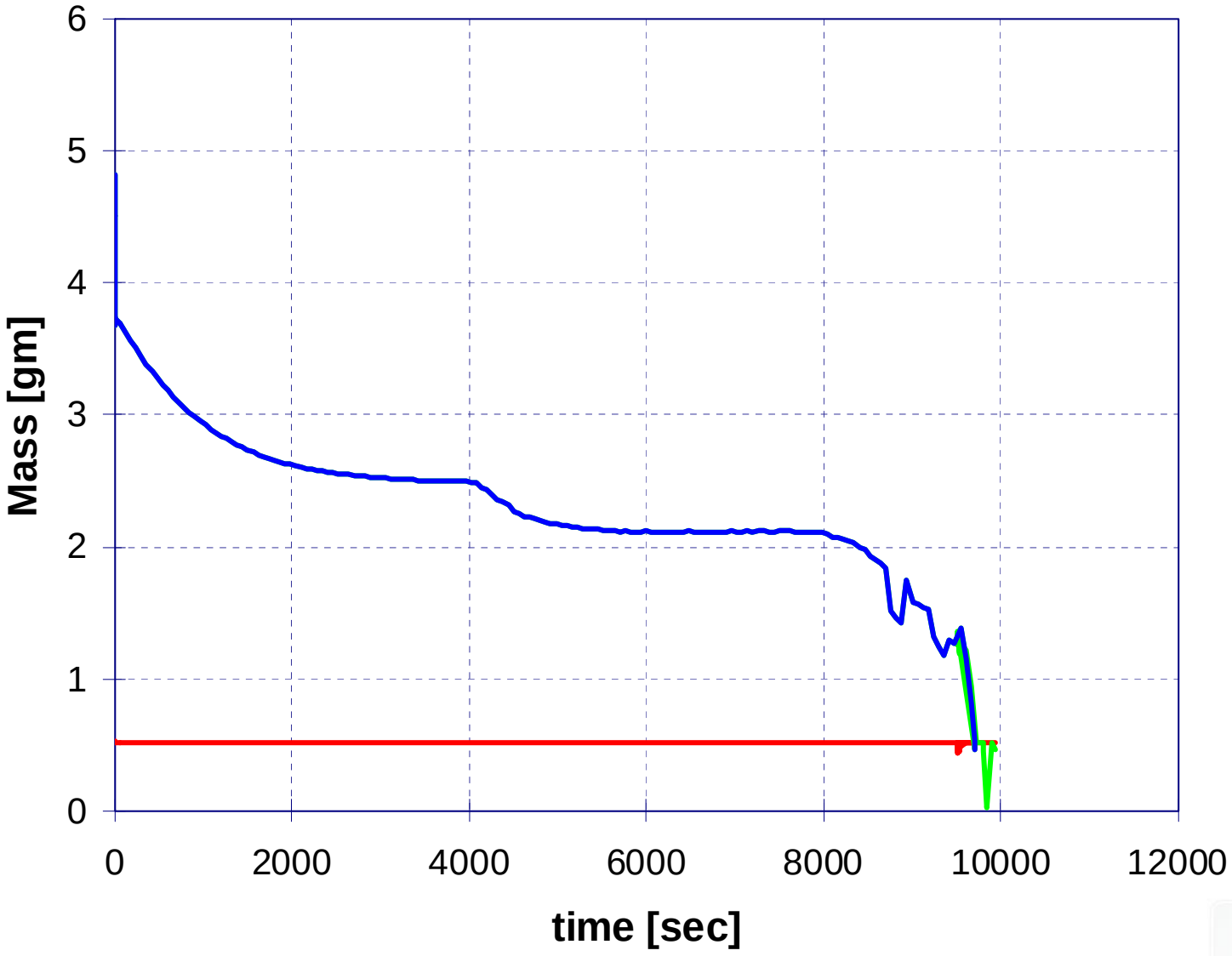
Some picx


Fuel and cladding temperature
Temperature [C]
2500
2000
1500
1000
500
0
0
2000
4000
6000
8000
10000
12000
time [sec]
oCOR-TFU.110
oCOR-TCL.110
nCOR-TFU.110
nCOR-TCL.110

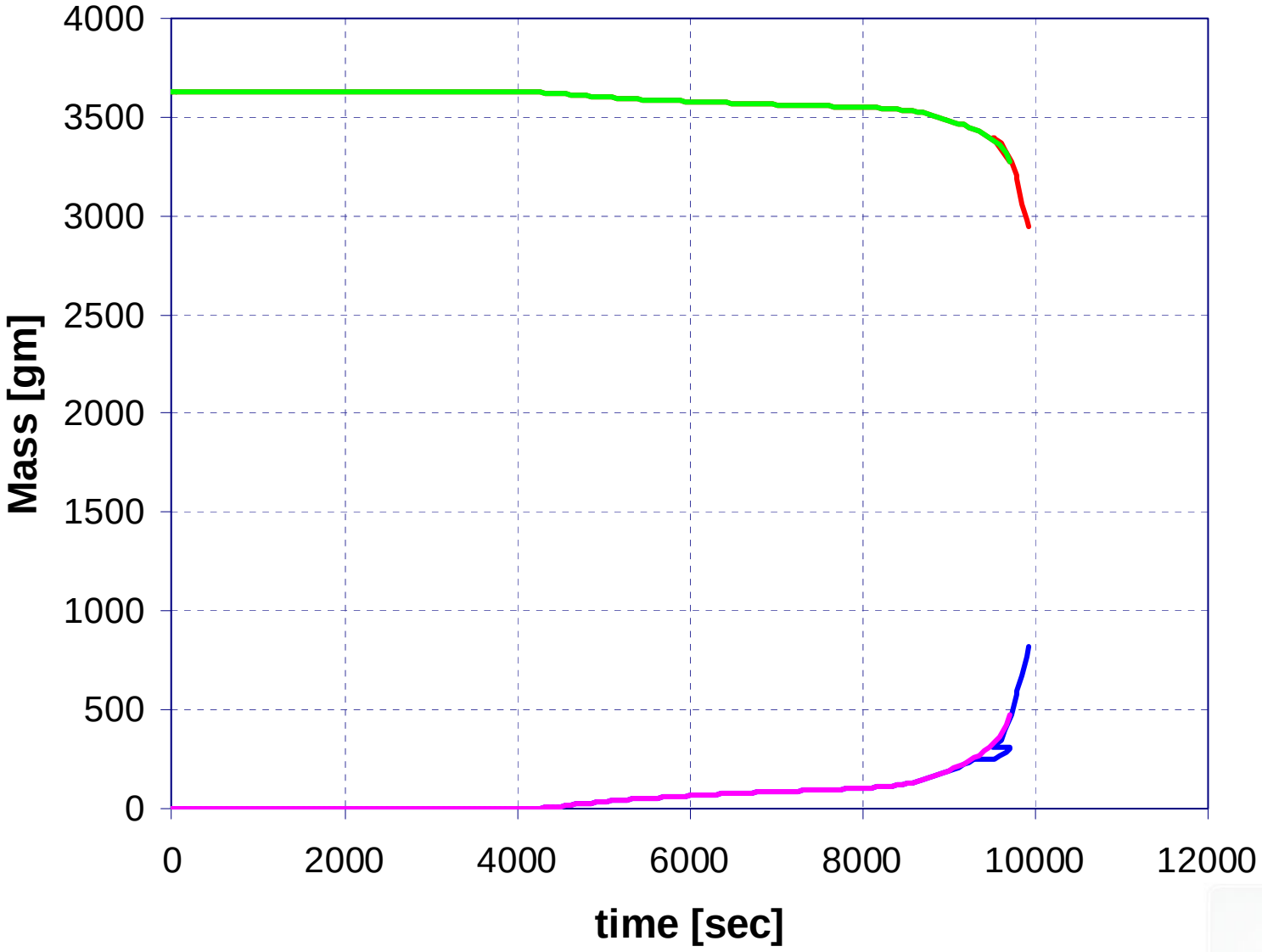
Some picx


Steam temperature
Temperature [C]
time [sec]
0
200
400
600
800
1000
1200
1400
0
2000
4000
6000
8000
10000
12000
CVH-TVAP.110
oCVH-TVAP.120
nCVH-TVAP.120

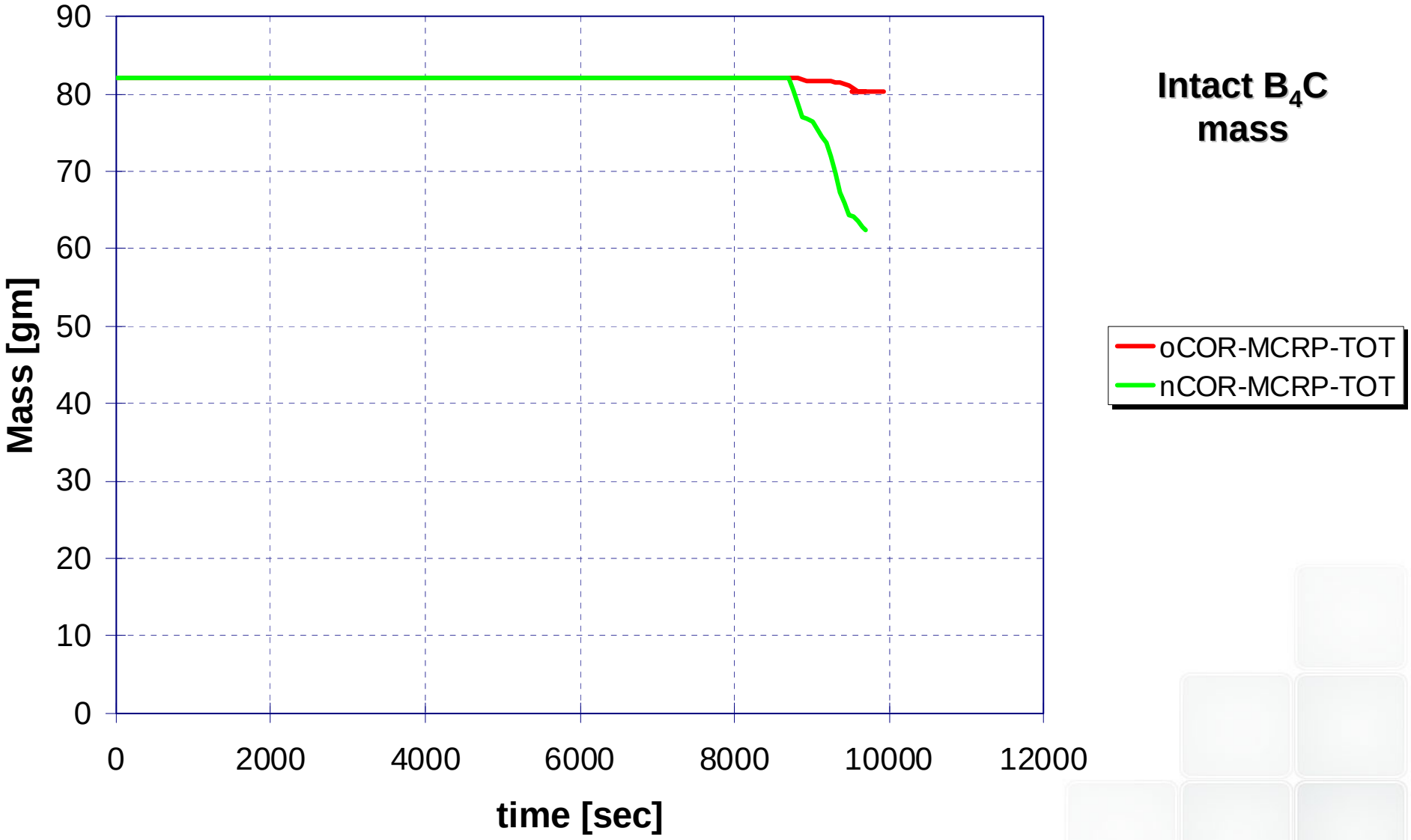
Some picx


Steam mass
Mass [gm]
time [sec]
0
1
2
3
4
5
6
0
2000
4000
6000
8000
10000
12000
CVH-MASS.3.110
oCVH-MASS.3.120
nCVH-MASS.3.120

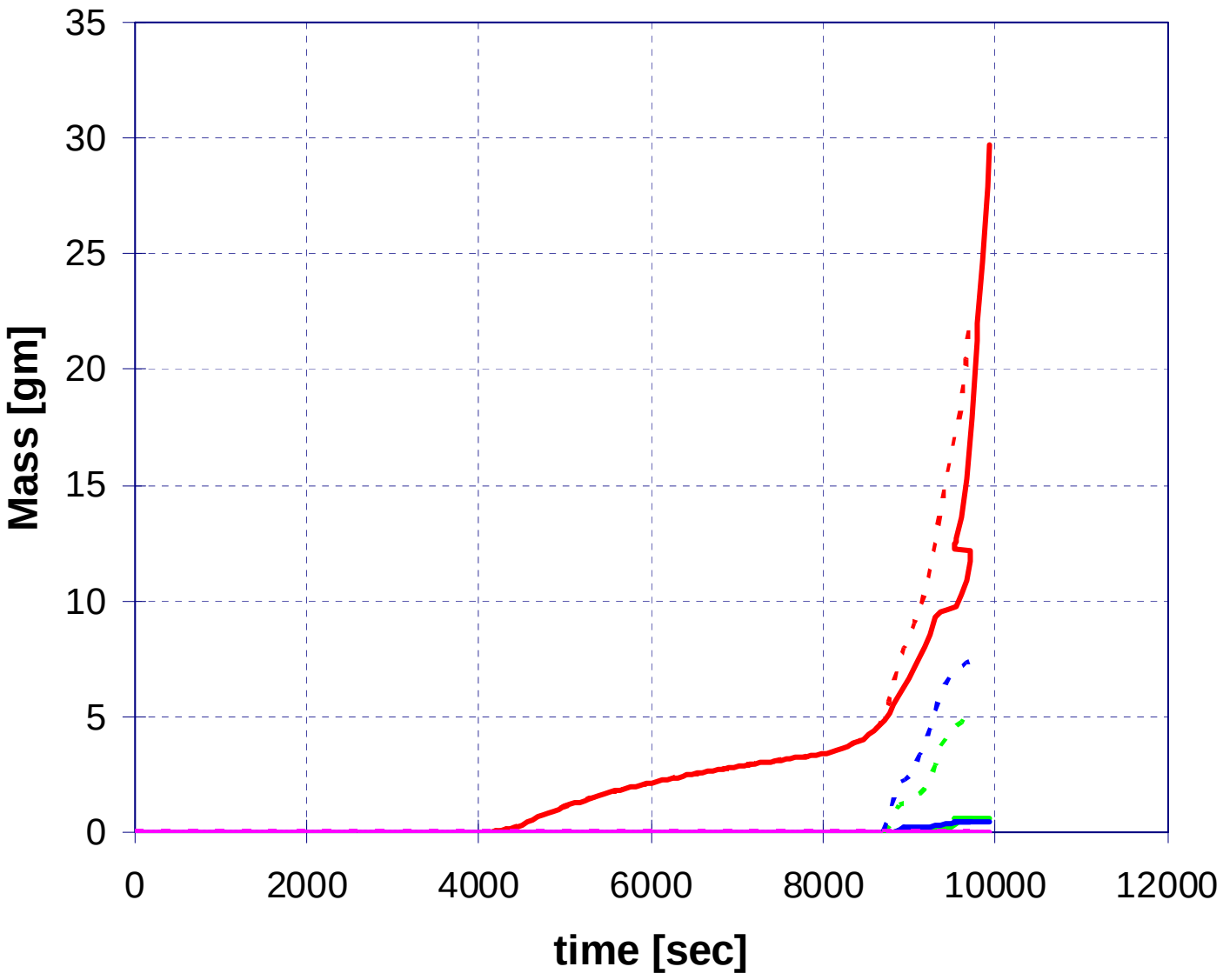
Some picx


Zr and ZrO2 mass
Mass [gm]
time [sec]
0
500
1000
1500
2000
2500
3000
3500
4000
0
2000
4000
6000
8000
10000
12000
oCOR-MZR-TOT
nCOR-MZR-TOT
oCOR-MZX-TOT
nCOR-MZX-TOT

Some picx


Intact B_4C mass
oCOR-MCRP-TOT
nCOR-MCRP-TOT
Mass [gm]
time [sec]
0
10
20
30
40
50
60
70
80
90
0
2000
4000
6000
8000
10000
12000

Some picx


35
30
25
20
15
10
5
0
Mass [gm]
0
2000
4000
6000
8000
10000
12000
time [sec]
Gas masses
oCOR-DMH2-TOT
oCOR-DMCO-TOT
oCOR-DMCO2-TOT
oCOR-DMCH4-TOT
nCOR-DMH2-TOT
nCOR-DMCO-TOT
nCOR-DMCO2-TOT
nCOR-DMCH4-TOT

Thanks for your attention!