

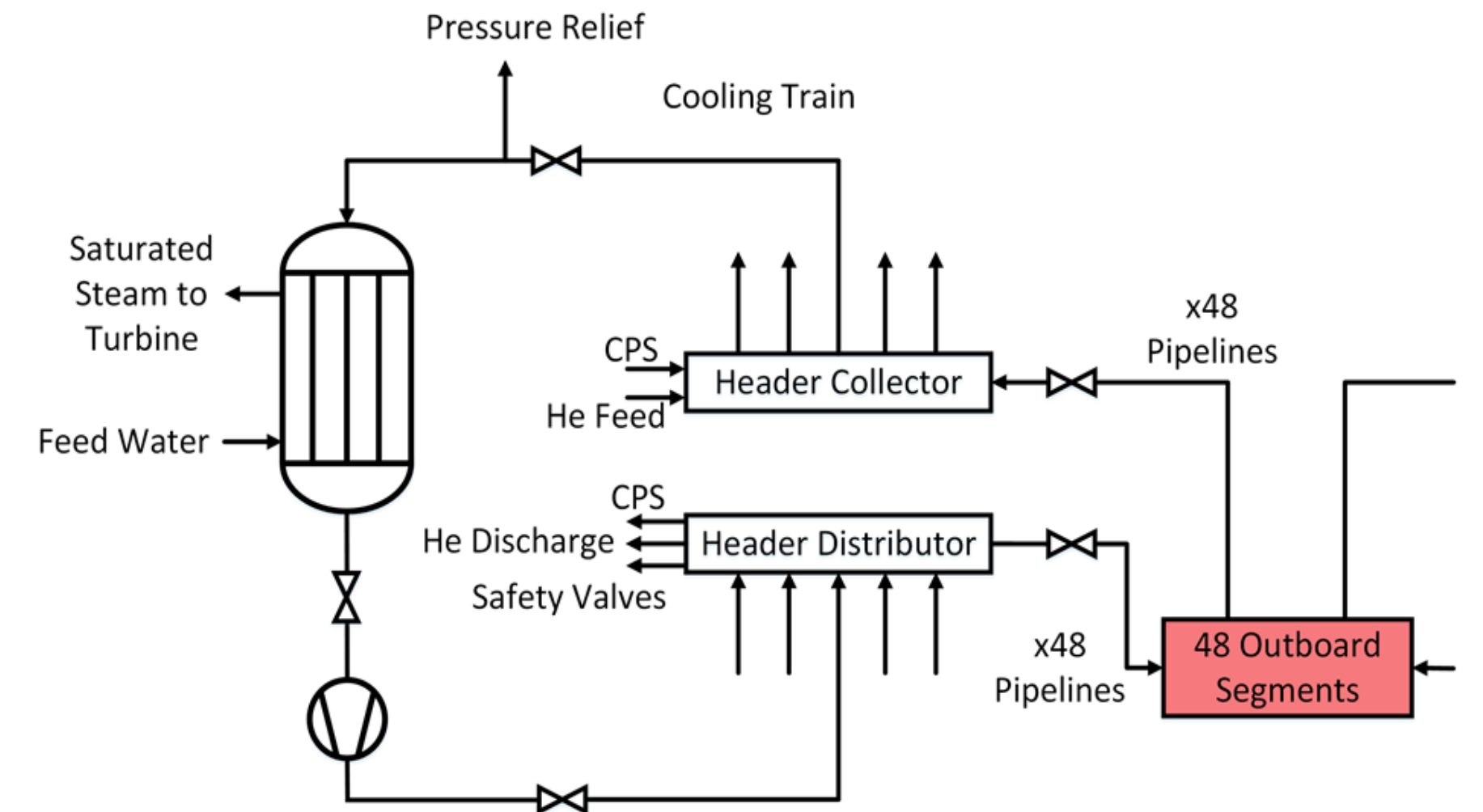
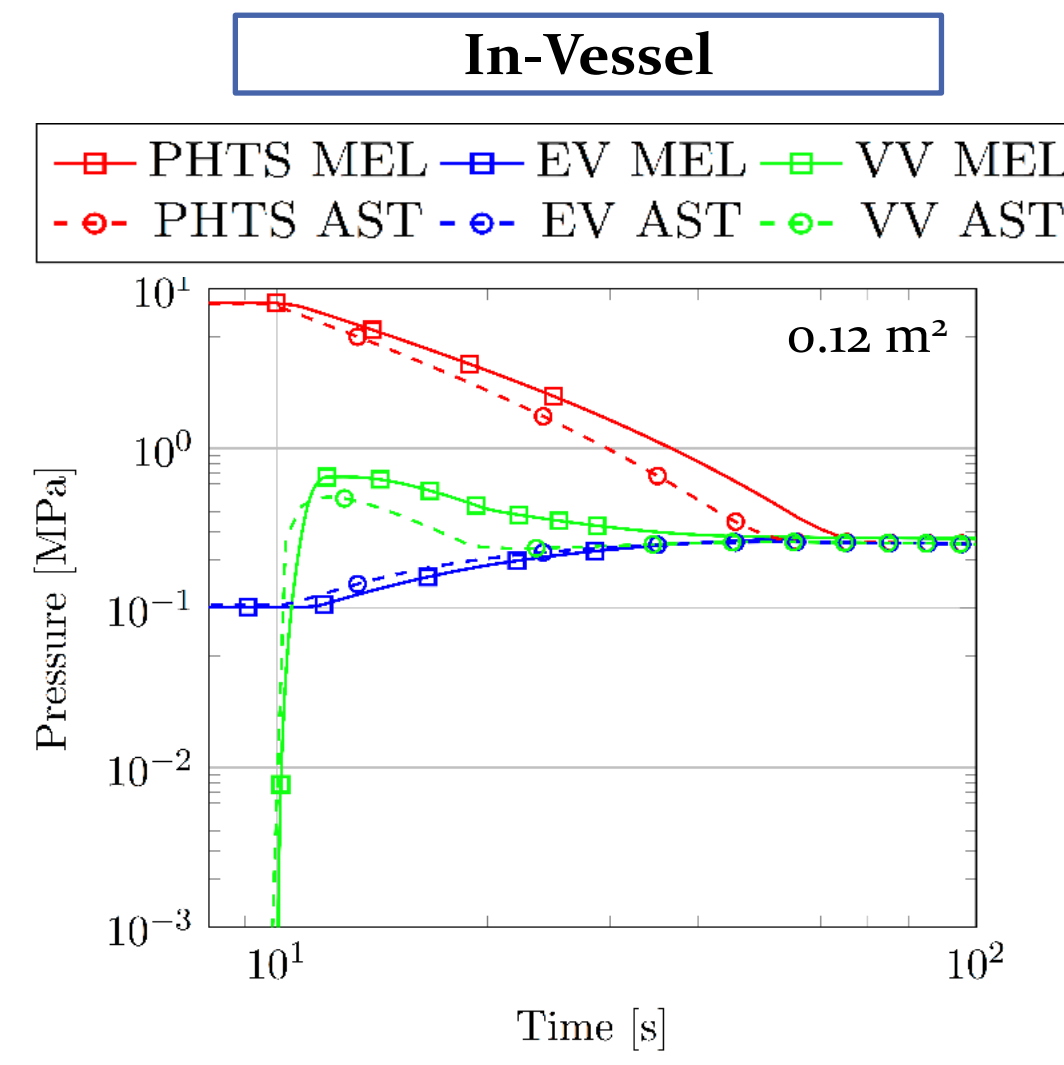
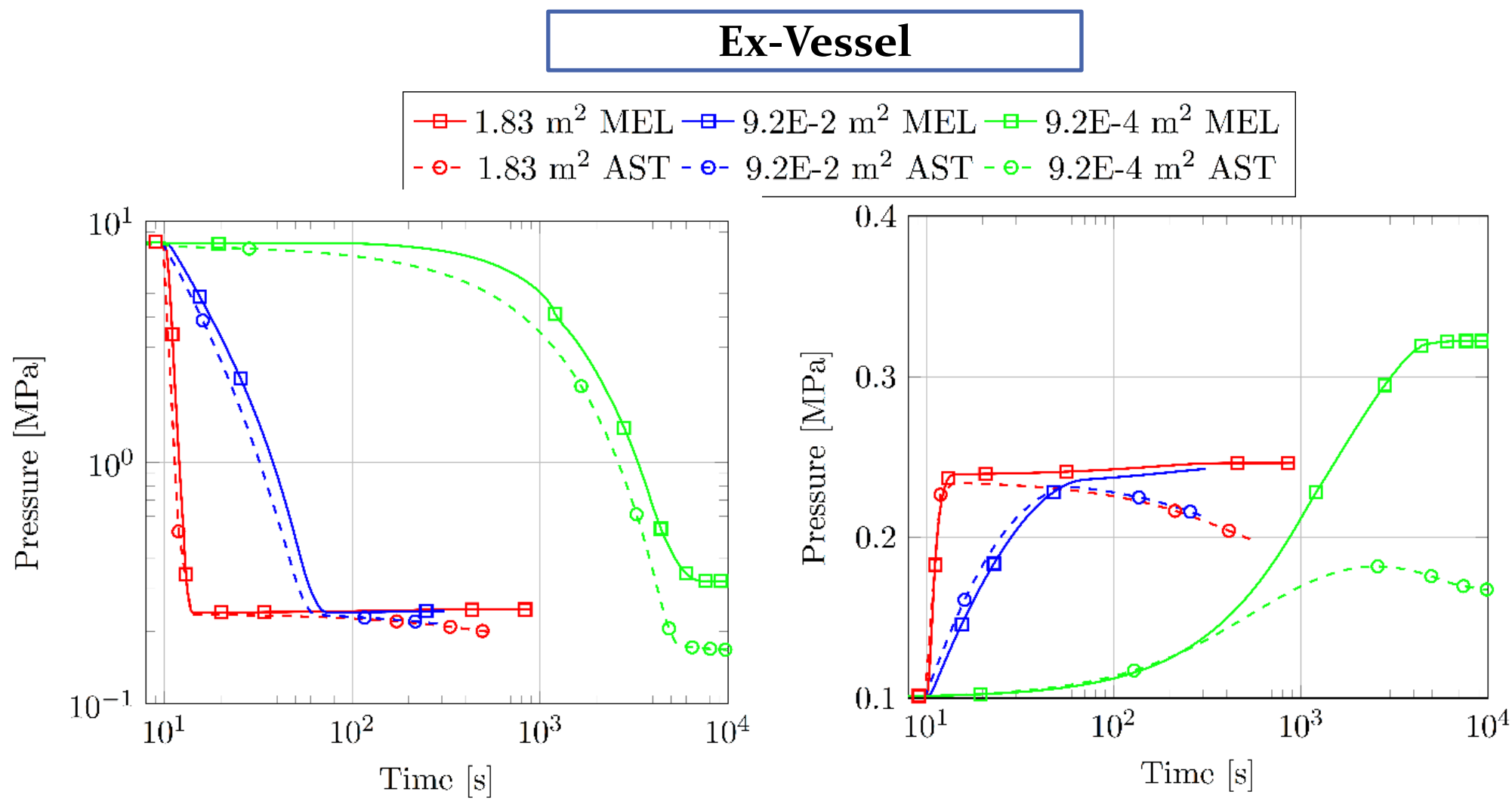
OBJECTIVES

- Provide a continuous validation of the main SA codes (ASTEC and MELCOR) internationally employed, through reference benchmark exercises, especially for the “ex-vessel” phase of the accident scenario.
- Application and validation of new physical models for the two SA codes applied to the safety analysis of future fusion reactors as DEMO. This step is fundamental for the future deployment of fusion reactors as alternative power source. In this step modelling modifications and improvements needed by the two main SA codes will be investigated, and possible solutions will be proposed.

ACTIVITIES

FUSION REACTORS – Activity carried out at Karlsruhe Institute of Technology (KIT)

- In the frame of European DEMO development program four different blanket systems are currently mentioned in the Road Map. One of these is the Helium Cooled Pebble Bed (HCPB) blanket, which is cooled by He and employs Li pebbles as a tritium breeding material.
- Two of the most challenging accidents are a large break Loss of Coolant Accident (LOCA) of the Primary Heat Transfer System (PHTS) inside and outside the Vacuum Vessel (VV).
- An analysis of such scenarios has been executed to provide useful tips to reduce the severity of these events, and to investigate the differences among the ASTEC 2.0 and the MELCOR 1.8.2 codes.



SAFETY

- Only very small breaks can be managed through the actuation of safety valves.
- The maximum pressure expected in the VV is well below the design limit (2 MPa)

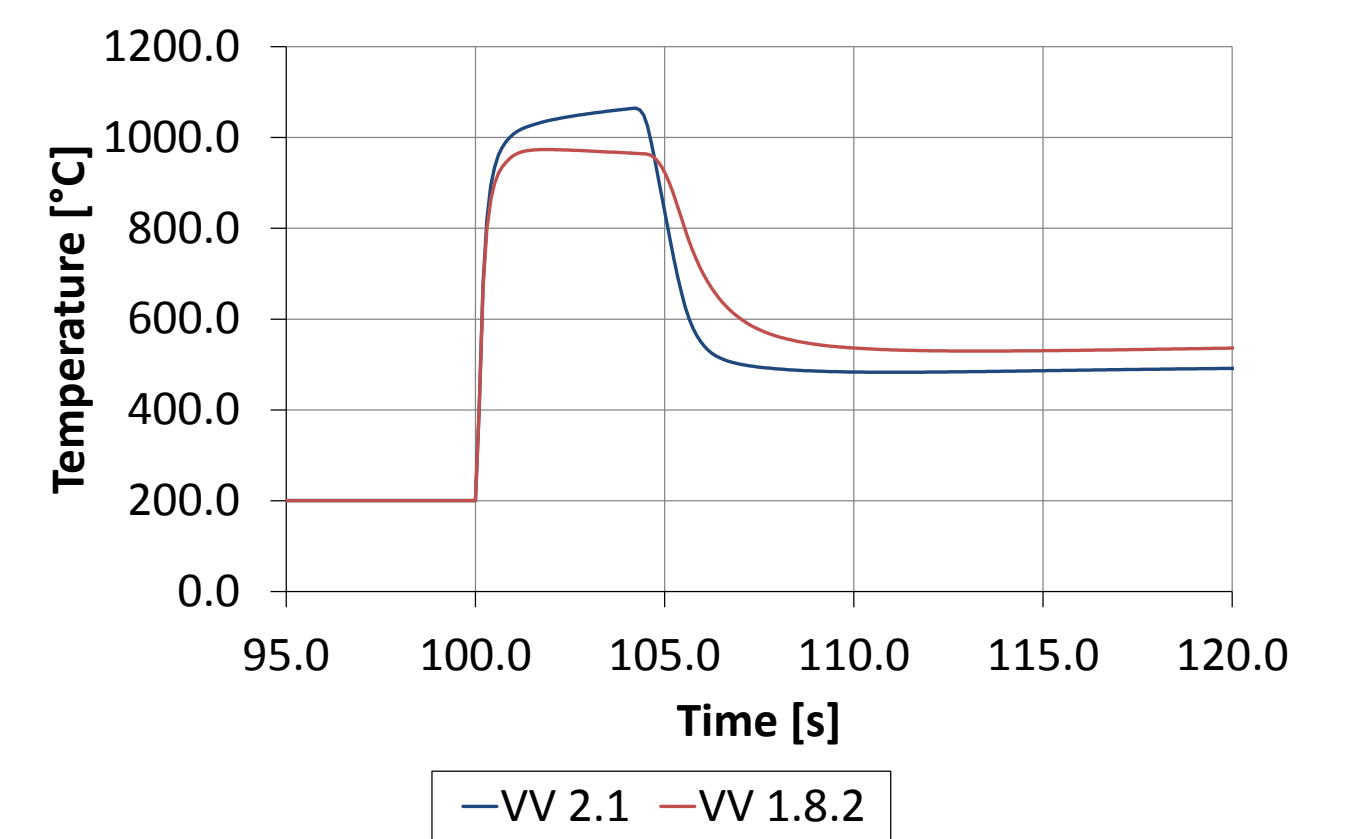
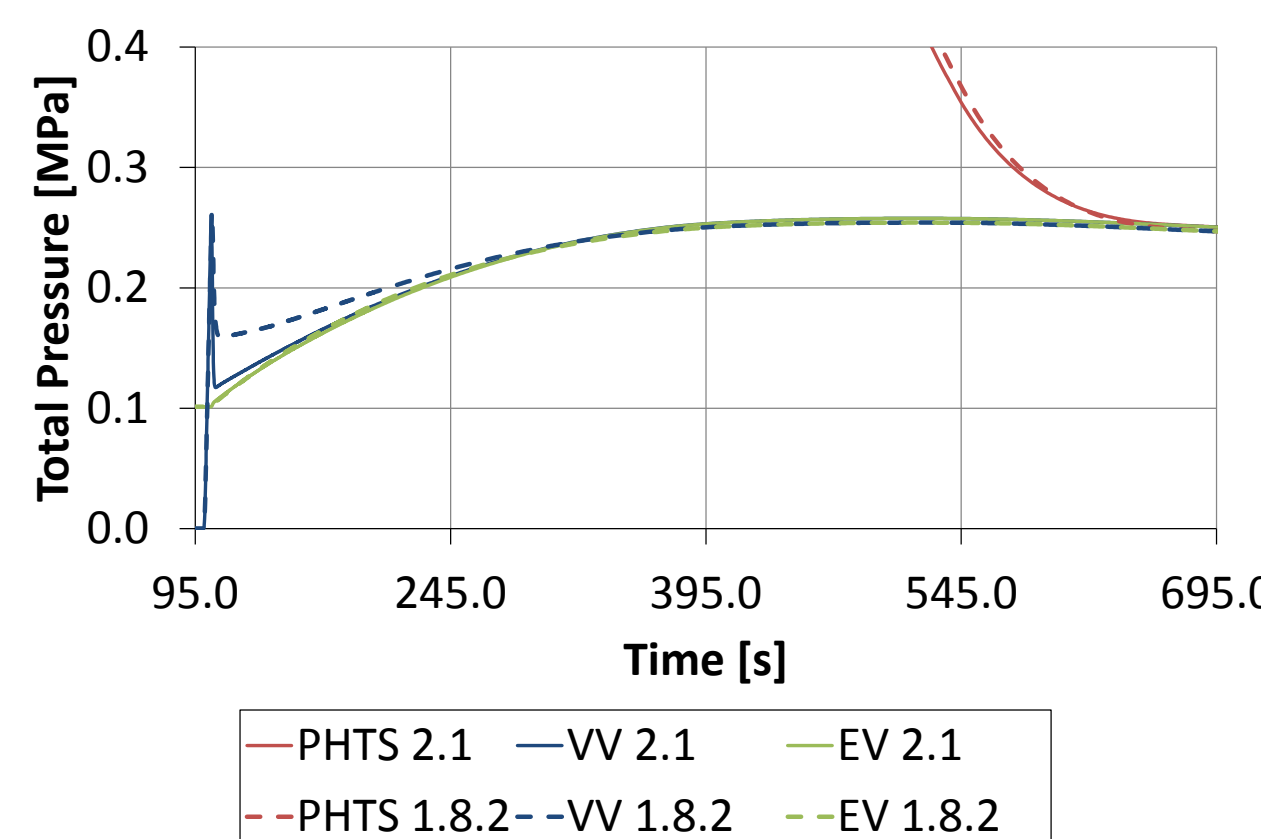
ASTEC

- Helium is not a «working fluid».
- Helium do not participate to the heat transfer process.
- Helium should be added as «working fluid» inside the code in order to be able to simulate DEMO (or any helium cooled plant).

MELCOR

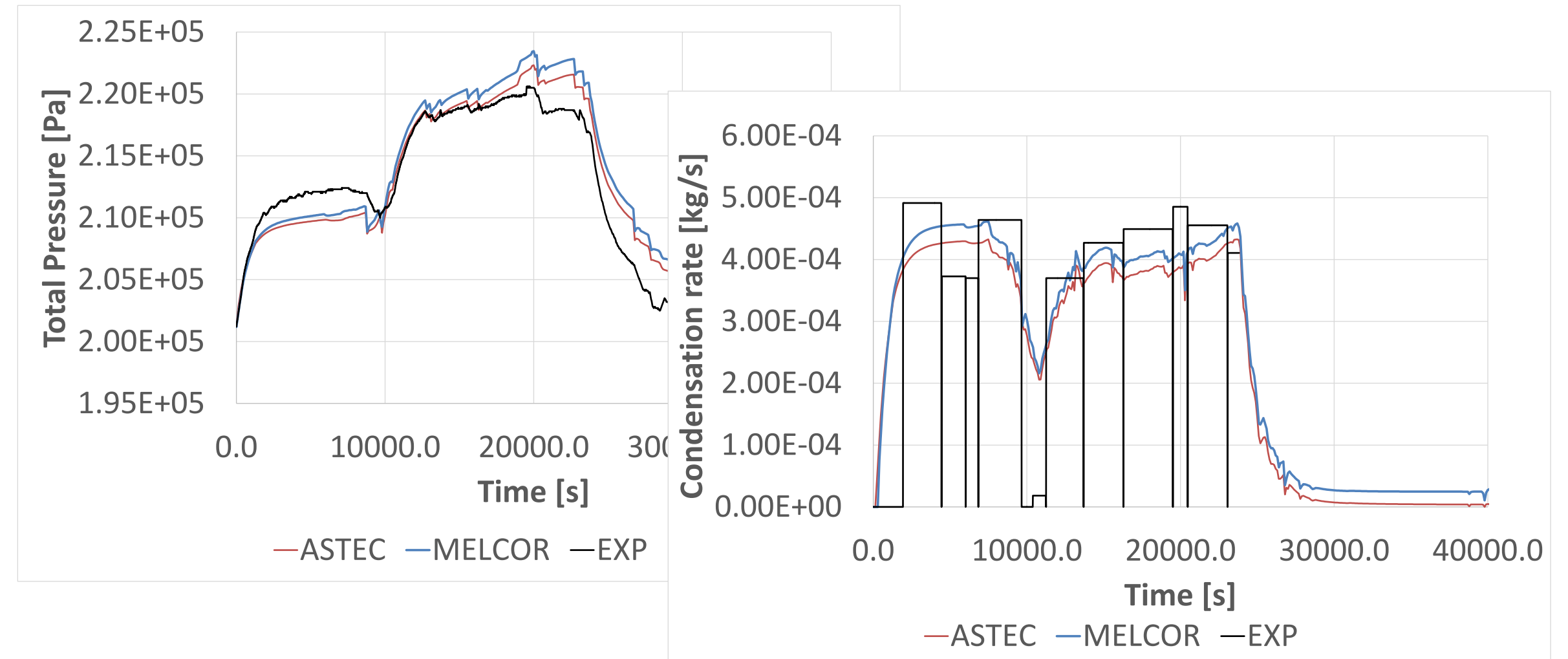
- Good results, but the 1.8.2 version is no longer maintained.
- Newer LWR 2.1.x versions should be expanded to cover also fusion plants as the old 1.8.x versions.

- A comparison among the old MELCOR 1.8.2 version and the newer MELCOR 2.1.6342 has been executed against an In-Vessel LOCA of the size of 0.12 m².
- The latest MELCOR versions have been expanded to cope also with helium cooled reactors, so they should be able to treat in a basic manner the main phenomena occurring during a LOCA in the DEMO reactor.



Light Water reactors

- The PHEBUS facility is a 1:5000 reproduction of a typical French PWR. In such facility during the last 25 years 5 tests were carried out to simulate a severe accident and the following dispersion of Fission Products (FPs) through the primary system and the containment.
- The main differences among these tests were: the fuel burn-up; the steam-content inside the vessel; and the control rod material.
- Basing on the data obtained from these 5 tests, new FP dispersion and partition models were created, as well as, several verification and validation activities were executed through national and international programs.
- A stand-alone containment analysis is now under progress in my PhD. The aim of this activity is to executed a code-to-code comparison among the ASTEC and the MELCOR code in order to:
 - Demonstrate that identical nodalizations provide similar (and good) results in both codes;
 - Shows that a single node nodalisation for the containment is not sufficient to catch the complex phenomena occurring during the test; and
 - Execute detailed sensitivity analyses to show the main parameters influencing the thermal-hydraulic transients, and the FPs behavior.



FUTURE ACTIVITIES

- IRSN (F) from January to July 2016.
- KIT (D) in September 2016 to end the activities on Fusion reactors.

COURSES

- «Severe Accident Phenomenology Short Course 2015», Stockholm (S), 6 – 10 July 2015. – 43 h -
- «International OECD/NEA-NUGENIA/SARNET Workshop on the “Progress in Iodine Behaviour for NPP Accident Analysis and Management”», Marseille (F), 30 March – 1 April 2015. – 22 h -
- «First NUGENIA-TA2/SARNET Workshop on Source Term», Marseille (F), 1 - 2 April 2015. – 10 h -

PUBLICATIONS & PRESENTATIONS

- D. Carloni, B. Gonfiotti, S. Paci, L. V. Boccaccini, “LOCA Accident for the DEMO Helium Cooled Blanket”, Fusion Science and Technology, Volume 68, September 2015, Pages 353 – 357.
- B. Gonfiotti, D. Carloni, S. Paci, L. V. Boccaccini, «Analyses of LOCAs in the Primary Heat Transfer System of the Helium Cooled Pebble Bed Blanket Concept», NURETH-16 Conference Proceedings, Chicago (USA), 30 August – 4 September 2015.
- B. Gonfiotti, S. Paci, «Comparison among MELCOR 1.8.2 fusion version and MELCOR 2.1 during normal and accidental scenarios for the Primary Heat Transfer System of the DEMO Helium Cooled Pebble Bed blanket», 33 UIT Heat Transfer Conference Proceedings, L'Aquila (I), 22 – 24 June 2015.
- B. Gonfiotti, S. Paci «Normal and Accidental scenarios analyses with MELCOR 1.8.2 and MELCOR 2.1 for the DEMO Helium Cooled Pebble Bed blanket concept», under revision for Science and Technology of Nuclear Installations.
- B. Gonfiotti, S. Paci, «Analysis on the applicability of the ASTEC and the MELCOR severe accident codes to incidental scenarios in fusion reactors», 6 ASTEC Users’ Club Conference Proceedings, Bologna (I), 23 – 26 February 2015.
- B. Gonfiotti, S. Paci, «Application of MELCOR 1.8.2 (fusion version) and MELCOR 2.1 on the DEMO Helium Cooled Pebble Bed blanket concept», 7 Meeting of the «European MELCOR User Group», Brussels (B), 17 – 18 March 2015.
- B. Gonfiotti, S. Paci, «Analysis of the THAI Iod-11 and Iod-12 tests: Advancements and limitations of ASTEC V2.0R3p1 and MELCOR V2.1.4803», Annals of Nuclear Energy, Volume 77, March 2015, Pages 451-476.