



**ELSMOR**

*Towards European Licensing of  
Small Modular Reactors*

# *Current Status of the ELSMOR Project*

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VTT

SYP2022



**ELSMOR**

# ELSMOR – General



- towards European licensing of SMRs
- Project aims at investigating selected safety features of LW-SMRs
- Focus on safety justification methodology for potentially challenging safety features of LW-SMRs
- 3.5 year research project started on 9/2019
- Project website: [www.elsmor.eu](http://www.elsmor.eu)
- Funded from the Euratom research and training programme 2014-2018 under Grant Agreement No. 847553

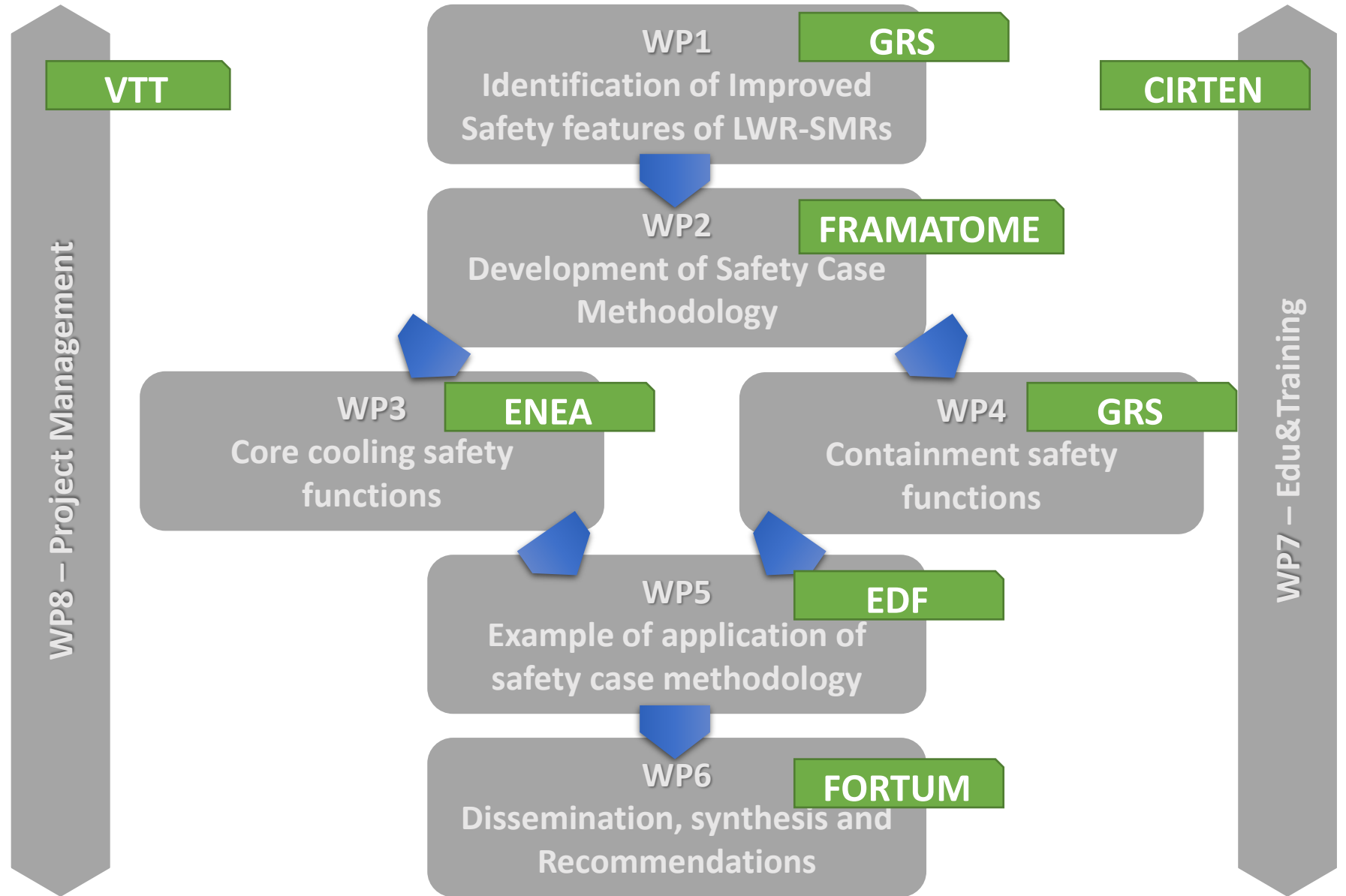
# ELSMOR – Project consortium

- 15 Partners
- 8 countries involved



# ELSMOR – Concept

- Investigation of selected safety features of LW-SMRs
  - Core cooling functions
  - Containment
- Research on methods for robust safety assessments
  - Several prior proposals / methodologies developed for both currently operating plants as well as non-conventional, e.g. for GenIV, fusion...
- Demonstration of the applicability of developed tools and methods
  - Test case "E-SMR" ("European SMR")
- Dissemination to stakeholders

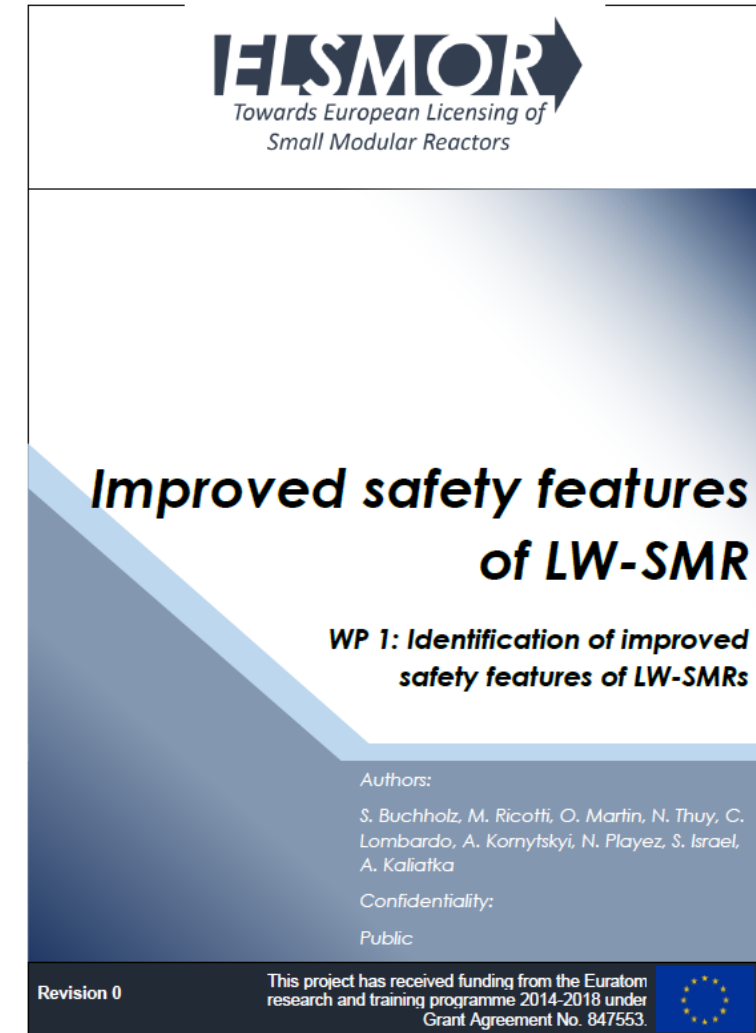


# *WP1: Review of improved safety features of LW-SMR*

- Screening of numerous safety directives and guidelines
  - No SMR specific directives and guidelines
  - Application of given regulations basically possible also for SMR
- Review of 21 LW-SMR designs
- Identification of potential challenges for SMR safety demonstration
- Documentation in public deliverable D1.1 (on ELSMOR Website <http://www.elsmor.eu>)

# WP1: Review of improved safety features of LW-SMR

- Extant high-level regulation relevant to the EU can be basically applied to LW-SMR
- Potentially challenging features for current safety demonstration methods include
  - Use of passive systems regarding reliability assessment consideration of single and common cause failures
  - Multi-unit sites, e.g. only one main control room
  - High burn-up core and new core materials
  - Severe accident mitigation affecting practical elimination and emergency planning zones



# *WP2: Development of safety analysis methodology for LW-SMRs*

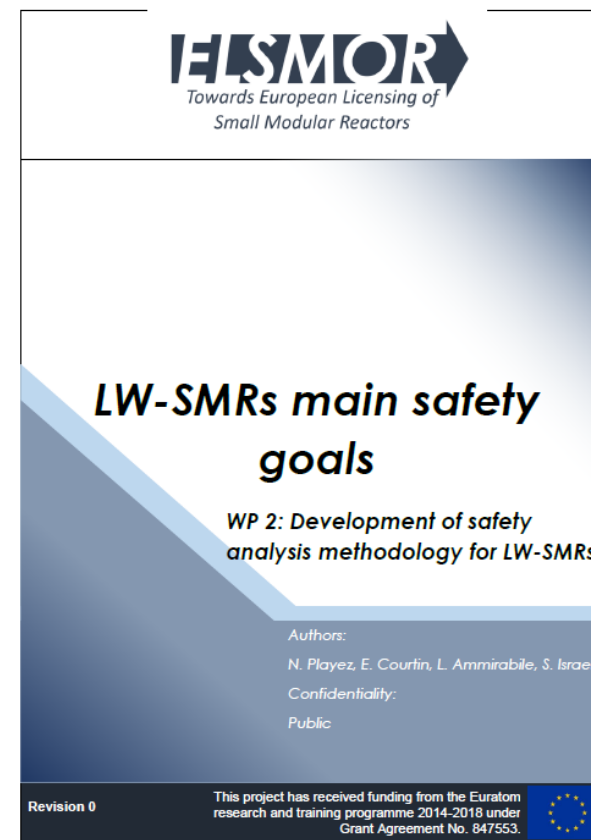
WP2 focuses on developing a methodology with qualitative and quantitative recommendations to support the safety demonstration of LW-SMRs.

- Complementary methodology development
  - Assessing the applicability of technology neutral Integrated Safety Assessment Method (ISAM) developed by GenIV International Forum
  - Systems engineering approach
- Various aspects of SMRs
  - High-level objectives (reactivity control, core cooling, containment)
  - Multi-unit plants, human factors, decommissioning, fuel management



# WP2: Status of Work

- Work still in progress, already available:
  - LW-SMRs main safety goals
  - Overview of safety methodologies für innovative reactor designs, and proposal of a general methodology for LW-SMR
- Available methods give suitable basis, work on specific safety functions is ongoing
- A summary report is under development

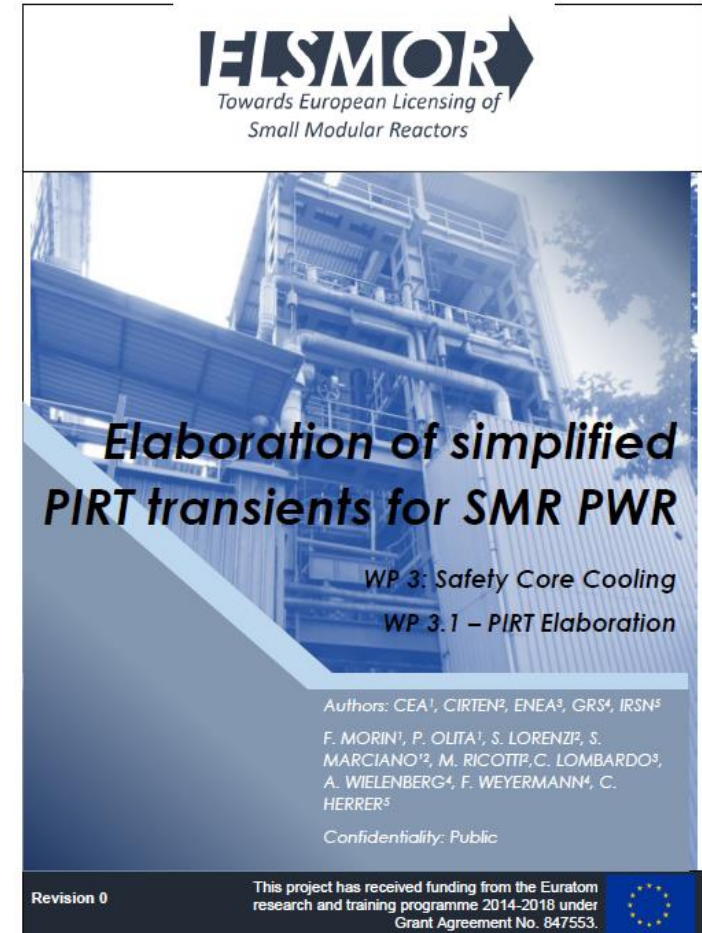


# WP2: Preliminary Conclusions

- SMR safety follows the same Defence-in-Depth principle as large power reactors, but with stronger emphasis on passive safety features. This creates some challenges, such as
  - Function of passive features and their uncertainties
  - Independence of DiD levels when passive systems are “always on”
- The use of innovative design options in certain SMR projects may raise some extra issues, for instance, for boron free concepts (for which, the consideration of the criticality risk during fuel handling could be enhanced).
- The design of a multi-unit facility, which is an SMR specificity as several modules would be operated on the same facility, is an issue to consider
- Assessment of severe accidents; their practical elimination, the effect of multiple units, the effect on emergency planning zones etc.

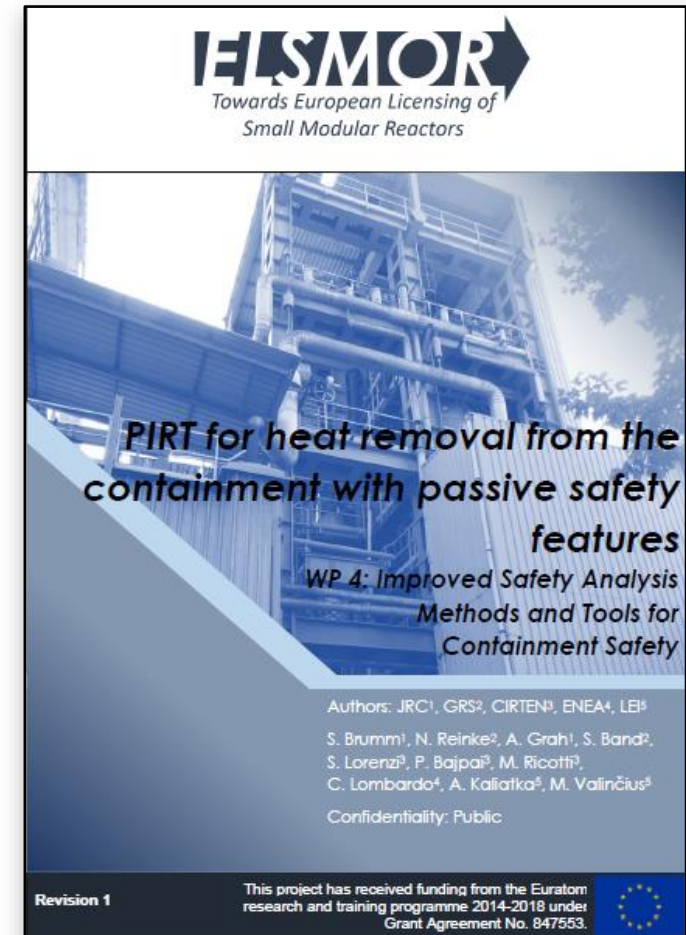
# WP3: Cooling safety function

- First PIRT (Phenomena Identification and Ranking Table) for transients in iPWR SMRs
  - Loss of off-site power and Loss of coolant accidents
  - Phenomena relevant and knowledge level
- Identification of experiments for the validation of evidence tools for SMR safety demonstration
  - HERO-2, PERSEO, PANTHERS, PANDA, EHRS
  - Validation of evidence tools like CATHARE and AC<sup>2</sup>/ATHLET
- New experiment on a plate heat exchanger for an intermediate passive heat removal circuit at SIET



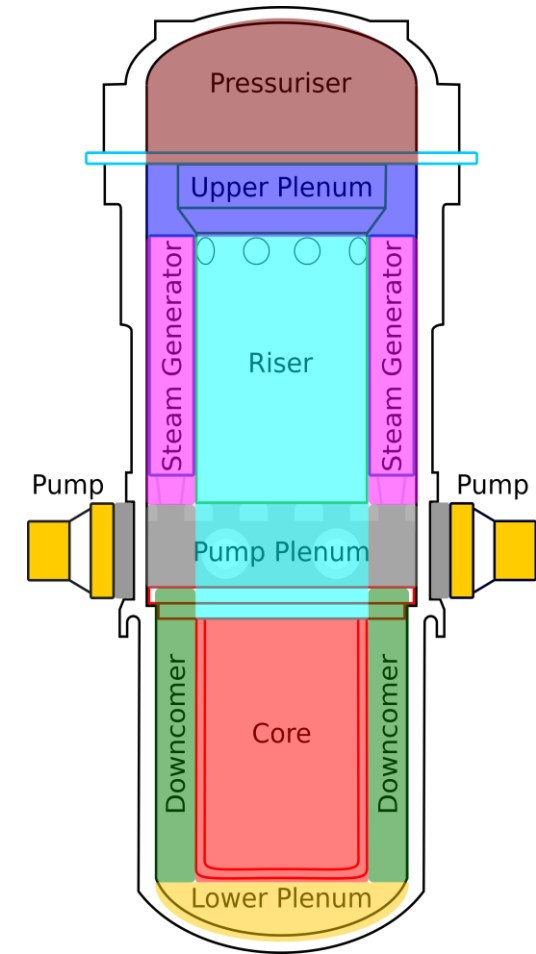
# WP4: Containment

- Elaboration of a PIRT on containment heat removal for DBA and DEC including severe accidents
  - Focus on submerged containments
  - Phenomena by relevance and knowledge level
- Experiments at characteristic length for containment walls are not available
  - Need for scaling
- Simulation of a test case for a submerged containment ongoing with
  - CATHARE, AC<sup>2</sup>, GOTHIC, CFX, STAR-CCM+



# WP5: Example of application of safety case methodology

- Scarce public data for NUWARD design
- Definition of E-SMR (European SMR) for simulations
  - Aim to create a public benchmark model for use
  - First out of consortium use in future TANDEM project
- Parallel creation of system code models
  - ASTEC, CATHARE, APROS, AC<sup>2</sup>, RELAP, MELCOR
  - Analysis of DBA and severe accident upcoming



# Thank you for your attention

- Project website:
  - [www.elsmor.eu](http://www.elsmor.eu)

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# HEASMOOR

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