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IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

ASSAS
ARTIFICIAL INTELLIGENCE FOR THE SIMULATION OF SEVERE ACCIDENTS
IAEA – COORDINATED RESEARCH PROGRAMME

Bastien POUBEAU

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MEMBRE DE ETSON

ASSAS overview

- Main objective: Developing a proof-of-concept for a severe accident simulator
- Budget: 4 M€, including 3 M€ from the EU (Horizon Euratom programme)
- Labelled by SNETP in August 2021
- 14 Partners:
  - IRSN (coordinator), JSI (Slovenia), KIT (Germany), KTH (Sweden), Tecnatom (Spain), ENEA (Italy), TU Delft (Netherlands), CS Group (France), PHIMECA (France), Ciemat (Spain), IVS (Slovakia), Energorisk (Ukraine), BelV (Belgium), PSI (Switzerland, associated partner)
- Calendar: November 2022 – October 2026
- Coordinator contact: Bastien POUBEAU (bastien.poubeau@irsn.fr)

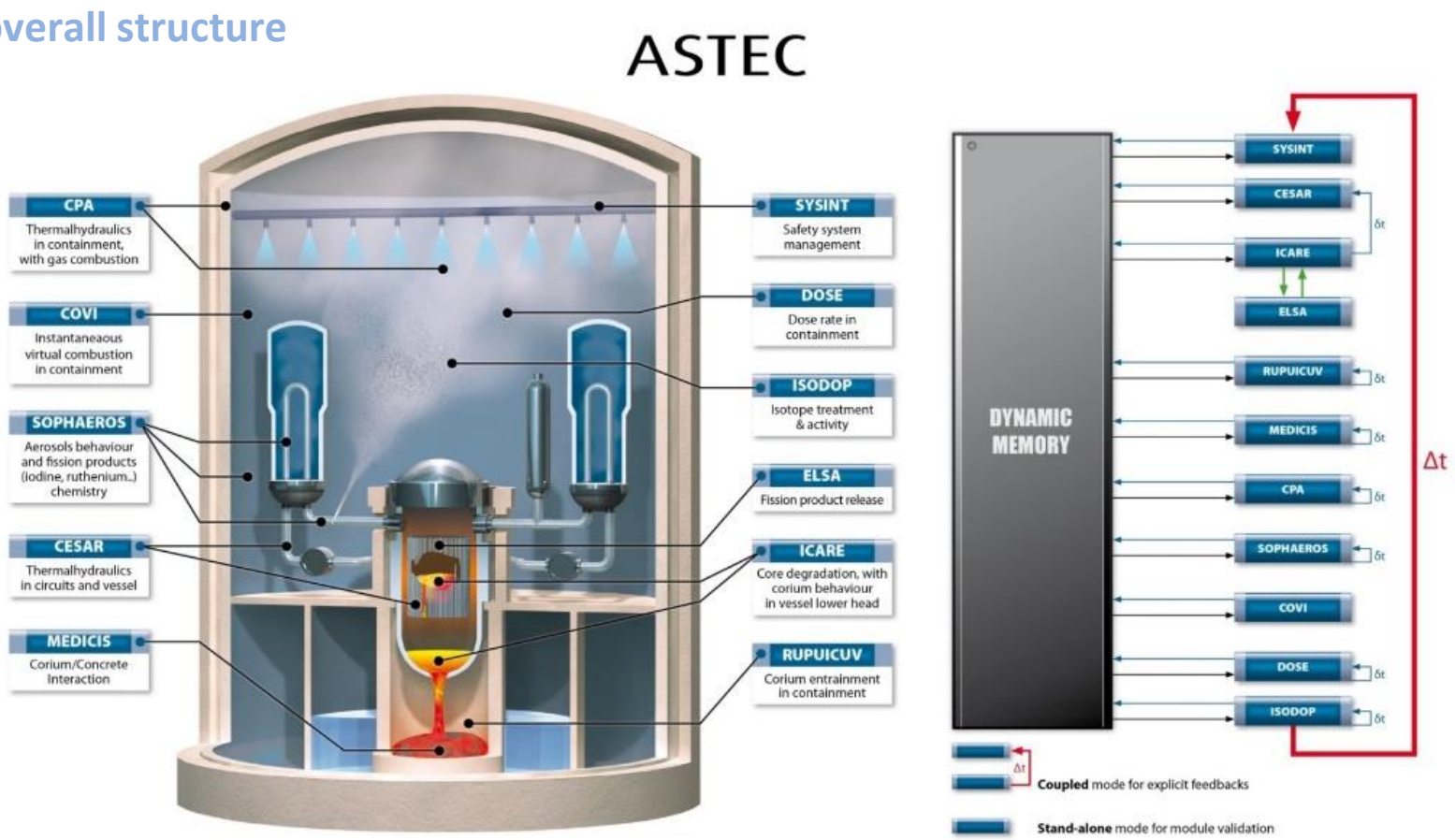
Scientific objectives

- Developing a “basic-principles” severe accident simulator for a generic western-type PWR
  - Interfacing ASTEC with Tecnatom’s simulation environment
  - Achieving real-time execution for training purposes
  - A proof-of-concept to prepare more complex simulators in the future

- Improving severe accident codes to meet the requirements of a simulator
  - Optimisation of ASTEC’s source code and nodalization
  - Development of surrogate models based on Artificial Intelligence for ASTEC and MELCOR

- Support the adoption of machine-learning approaches in nuclear science
  - The severe accident sequence database used to train AI models will be in open access
  - Methodologies can be applied to other multi-physics codes

ASTEC overall structure



Use of artificial intelligence: data-driven reduced-order modelling

- The most innovative aspect of the project: many options explored in parallel

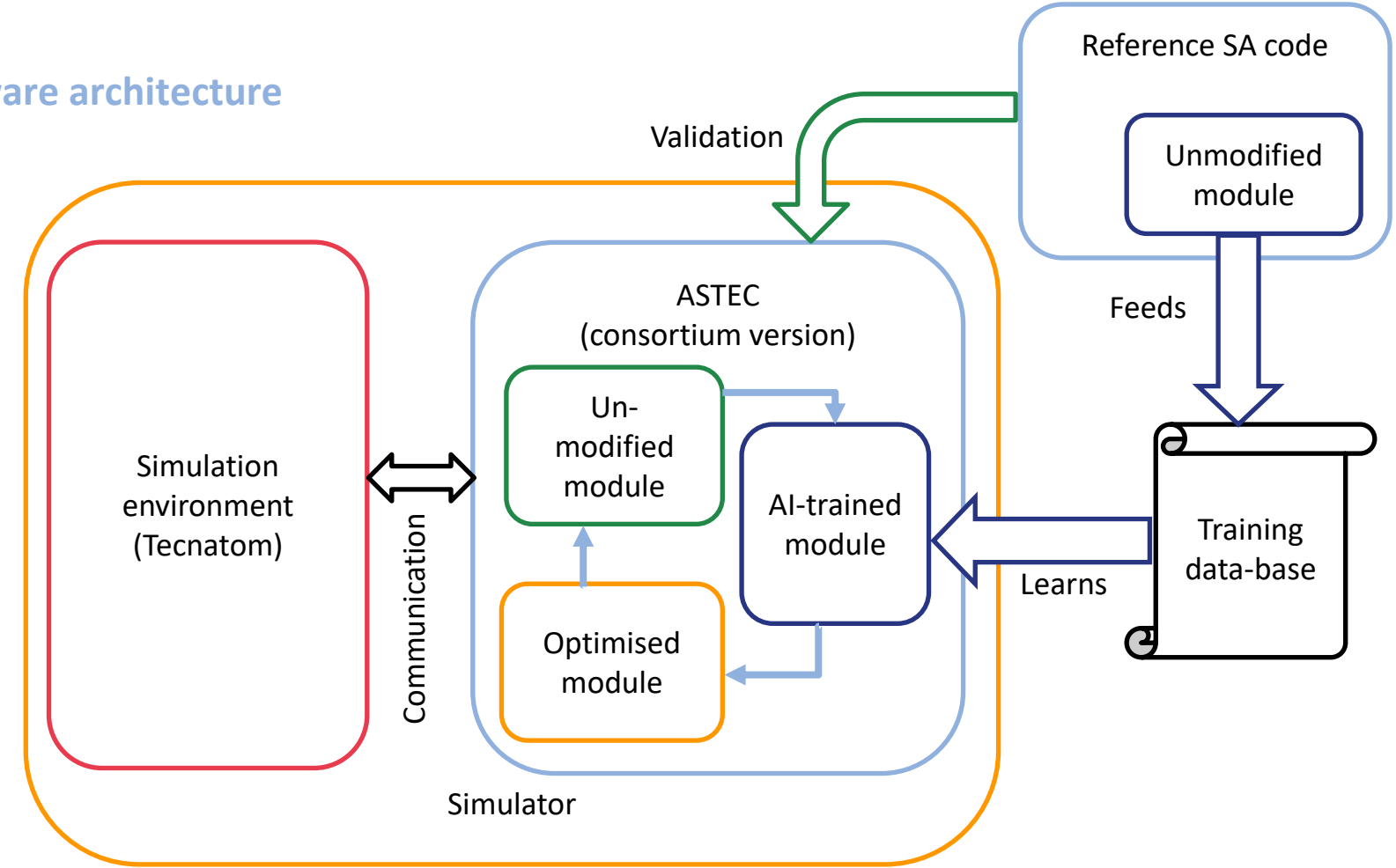
- Techniques to be used:
  - Regression techniques: Sparse dimension reduction coupled with strongly non-linear methods (like state-of-the-art neural networks)
  - Interpolation between precalculated sequences

- Scope of the surrogate model:
  - A specific system (primary loops, GVs, reactor core…)
  - A model, a module or group of modules in ASTEC (thermal-hydraulics…)
  - Complete code for a specific part of the simulation (post vessel-rupture phase…)
  - Only best-estimate parameters will be used for the project

Work-packages

- Coordination (IRSN)
- Methodology: modelling strategy, support for the development of surrogate models (JSI)
- Generation of training databases for machine-learning (KIT)
- Surrogate model design and validation (KTH)
- Improving ASTEC's performance (IRSN)
- Developing the simulator and interfacing it with ASTEC (Tecnatom)
- Conclusion and dissemination (ENEA)

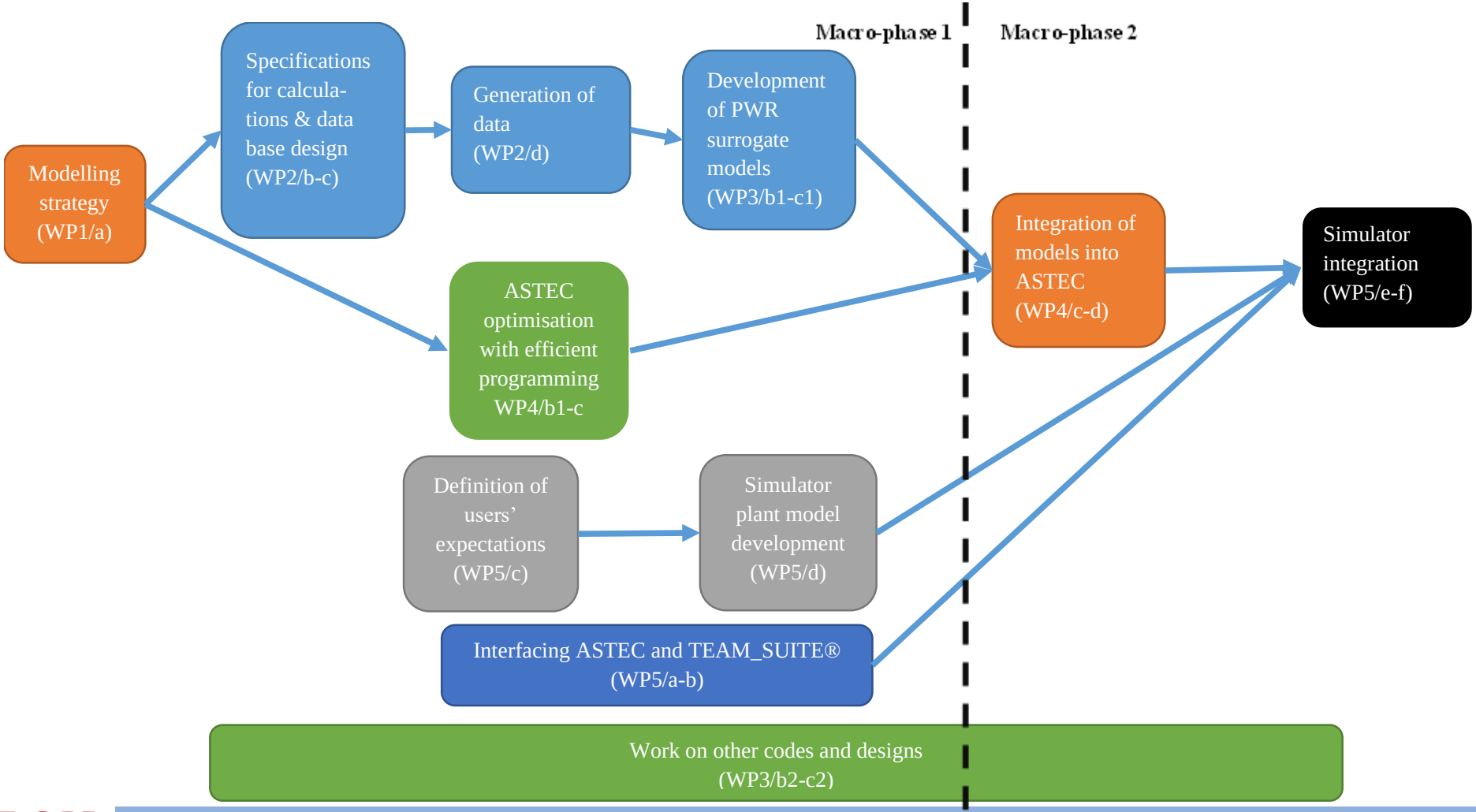
Software architecture



Interactions with IAEA and CRP

- IAEA owns a suite of basic-principles simulators: ASSAS could extend the capabilities
- Machine-learning methods could be used for uncertainty propagation and sensitivity analysis
- ASTEC's performances will be improved
- Observers (end-user group) and in-kind contributors are still welcome in the project

Thank you for your attention!


Macro-phase 1
Macro-phase 2
Modelling strategy (WP1/a)
Specifications for calcula-tions & data base design (WP2/b-c)
Generation of data (WP2/d)
Development of PWR surrogate models (WP3/b1-c1)
ASTEC optimisation with efficient programming WP4/b1-c
Integration of models into ASTEC (WP4/c-d)
Simulator integration (WP5/e-f)
Definition of users' expectations (WP5/c)
Simulator plant model development (WP5/d)
Interfacing ASTEC and TEAM_SUITE® (WP5/a-b)
Work on other codes and designs (WP3/b2-c2)