THE METIS PROJECT NEWSLETTER

FOURTH EDITION

WELCOME TO THE FOURTH METIS PROJECT NEWSLETTER

Welcome to the latest METIS newsletter! In this issue, we delve into the project's recent advancements in seismic risk assessment. Discover how the project has worked towards refining hazard and ground motion analysis, site response modelling, fragility assessment, and risk quantification.

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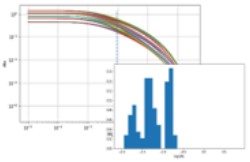
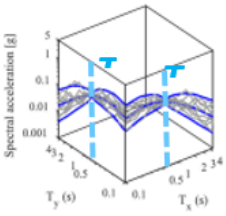
<td>  </td>
<td>  </td>
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<td>Seismic hazard at rock</td>
<td>Site response and ground motion</td>
<td>SSCs response and fragility</td>
<td>Risk quantification</td>
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Seismic Risk Assessment for Nuclear Safety</td>
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As the METIS project comes towards its end in May 2025, we also highlight the key METIS events from this summer and invite you to join us for the METIS Final Symposium on 21 May 2025 to learn about METIS, its outcomes, and perspectives for future research. Please find the relevant information in the events section below.

Irmela Zentner (METIS Project Coordinator)

TOPIC FOCUS

New Methods and Tools for Seismic PRA: SCRAM++

Probabilistic Risk Assessment (PRA) is a critical tool in nuclear safety. However, analysing large and complex fault trees, a key component of PRA, remains a computational challenge. This article introduces a novel approach using Compressed Truth Tables (CTT) to improve the efficiency and accuracy of fault tree analysis. The CTT algorithm, integrated into the SCRAM++ platform, offers significant advantages over traditional methods, enabling more reliable risk assessments for nuclear power plants.

Read the full article

METIS Case Study – Integrated Approach to Compute Floor Response and Fragility Including Site Response

This article explores the integration of hazard and site response analysis within the METIS project. By combining conditional spectra and simulation-based fragility analysis, the researchers developed a comprehensive approach to assess seismic risk for nuclear power plants. The study focuses on a site in Italy and the Zaporizhzhia Nuclear Power Plant in Ukraine, investigating the impact of hazard and site response uncertainties on risk estimates. Through parametric and sensitivity analyses, the researchers identified the

benefits and limitations of different methodologies and highlighted the need for further research to refine hazard and site response assessments.

Read the full article

Computation of Fragility Curves for METIS Case Study

This article presents a detailed fragility analysis of critical structures and components at the Zaporizhzhia Nuclear Power Plant (ZNPP). Finite element models were developed to accurately capture nonlinear behaviour, and these models were subjected to ground motion inputs derived from the METIS case study, incorporating uncertainties in site response. The Cloud-regression methodology was employed to estimate the failure probabilities of structures and components, considering uncertainties in structural and component properties. The findings of this study provide valuable insights into the seismic vulnerability of the ZNPP and inform risk-informed decision-making for future upgrades and safety assessments.

Read the full article

METIS Peer Review Group

In the framework of WP3, a Peer Review Group has been formed with the goal to assess METIS methods and tools for seismic risk assessment and provide guidance to practitioners and perspectives for future research needs.

The Peer Review is conducted by members from METIS EAB and EUG. The Peer Review process kicked off on 7 November and consists of analysing the deliverables associated with the METIS case-study from the different work packages. In contrast to the separate deliverables, the peer review considers the full seismic PRA analysis chain to provide feedback on the proposed methodologies. It is expected that the output of the Peer Review provides valuable material for the METIS final handbook developed by WP2.

LEARN MORE ABOUT METIS

Explore New Tools on OpenMETIS Gitlab

PyPSHATest – Toolkit for Probabilistic Seismic Hazard Model to Data Comparison

This toolkit leverages upon OpenQuake and offers a range of functions to help hazard modellers and engineering seismologists explore differences between models and data in greater depth, and to make these comparisons a convenient, transparent and reproducible process in probabilistic seismic hazard model development and application.

Fragility Regression Code

Python code and notebook to compute and plot fragility curves using the regression (cloud) analysis approach. This approach allows to determine lognormal fragility parameters and allows for an analytical expression of the fragility curve.

PRA Uncertainty Propagation Tool

The PRA tool provides a new calculation framework for Seismic PSA, based on SCRAM code for Boolean computations, on Andromeda software for fault trees and event trees definition and user interface, and on a tool developed in the frame of METIS project for managing and generating seismic data (fragility and hazard). Given the samples of basic events probabilities and the results of the Seismic PSA model in terms of cutsets, the tool computes the value of the Core Damage Frequency (CDF) for each sample.

OpenMETIS Gitlab Repository

Discover the new METIS Deliverables

Explore the latest deliverables and project results from the METIS project as we come towards its end.

METIS Deliverables

METIS on Zenodo

To discover the latest research data and publications, visit METIS on Zenodo and find the open-access resources.

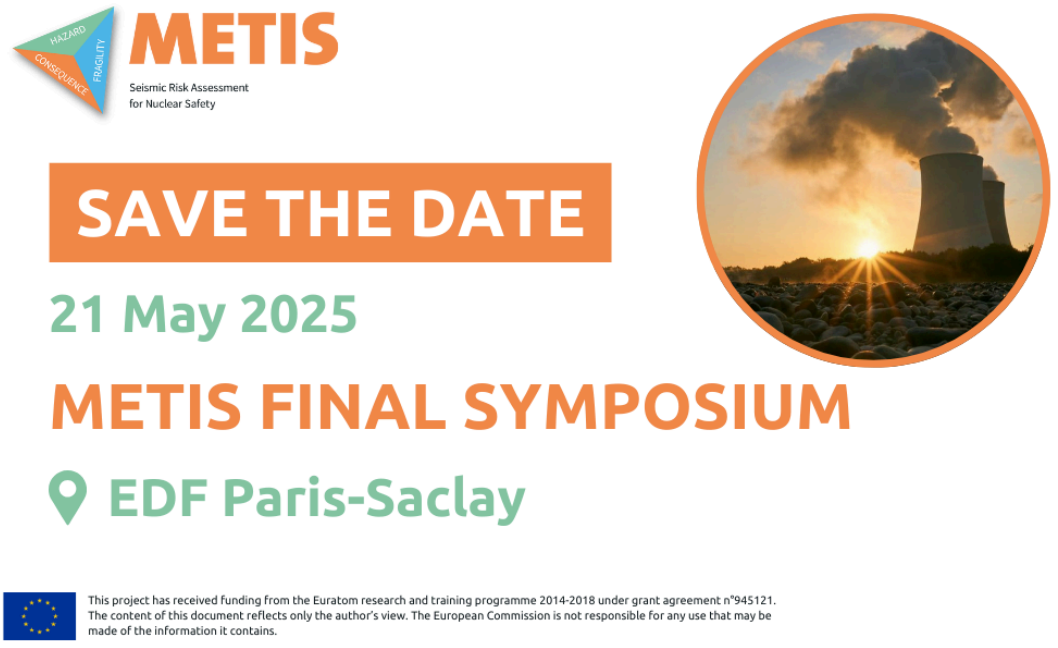
METIS on Zenodo

UPCOMING EVENTS

Happening in 2025:

- 28 April - 1 May 2025 - Summer School in Greece (Aegina Island)
- 21 May 2025 - METIS Final Symposium at EDF Paris-Saclay (detailed information below)
- 22-23 May 2025 - METIS consortium plenary meeting and technical visit

METIS Final Symposium



This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement n°945121. The content of this document reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

The METIS project is organising their Final Symposium on **21 May 2025** at Paris-Saclay, hosted by EDF R&D.

The day will be dedicated to presenting the METIS project's outcomes and results from the last five years which have sought to develop tools and methodologies (mainly the Probabilistic Safety Assessment methodology) used in seismic safety assessments of nuclear reactors which can be applied to industry. By aiming to provide more accurate evaluations of nuclear power plant resilience under different seismic conditions, the day will also harness new outlooks on further research needs looking beyond the project.

The METIS project invites external participants from all sectors interested in the nuclear field to register and attend the final project event!

Secure your spot and register below!

Please share within your networks to those who would be interested in attending the final event of the METIS project.

Find the event and more information, including the agenda, on our **website.**

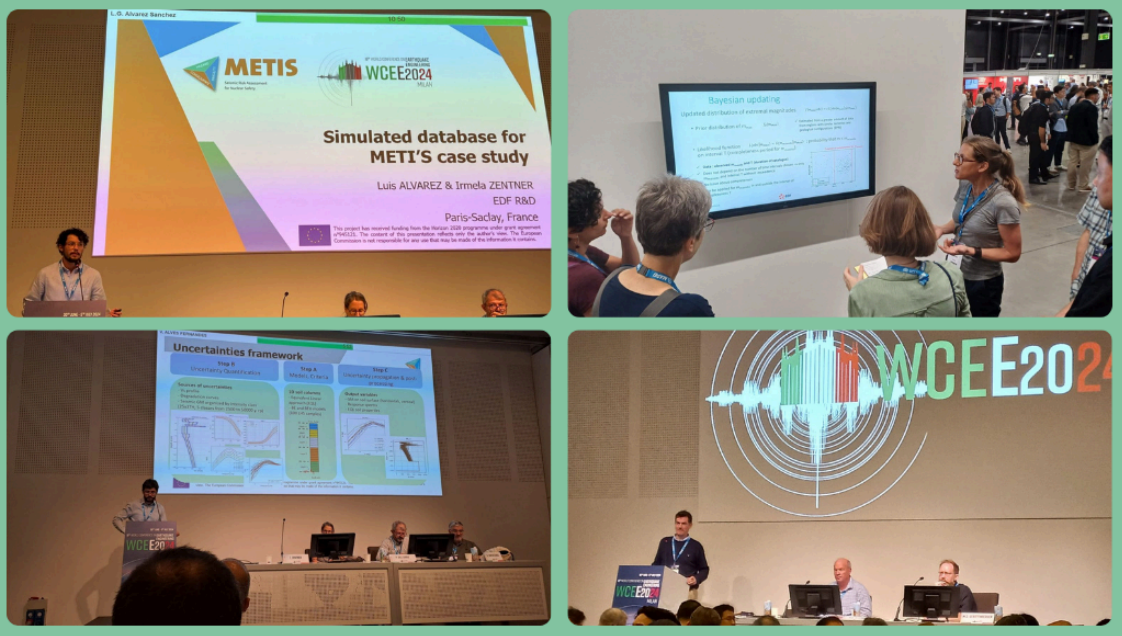
Note that the event is fully in-person and no online attendance is possible.

Register now

PAST EVENTS

30 June - 5 July 2024 / 18th WCEE 2024 Milan

METIS project partners Prof Dimitrios Vamvatsikos, Prof Paolo Bazzurro and METIS project coordinator Dr Irmela Zentner organised a special session to share on recent “Advances in the seismic hazard and risk assessment of nuclear power plants” at the WCEE in Milan. Through the 18 scientific papers presented in this session, the community explored recent advancements in methodologies to improve nuclear safety through more accurate seismic risk assessments. In particular, the METIS consortium presented a number of papers covering a range of in-depth analysis surrounding seismic hazard and analysis in nuclear safety. Read them here.



Read the full article

5 - 6 June 2024 / METIS Plenary Meeting in Ljubljana, Slovenia hosted by partner UL

The METIS consortium met in Slovenia for the plenary meeting and an on-site workshop. The METIS plenary took place over two days in Ljubljana hosted by Matjaz Dolsek (University of Ljubljana), attended by the METIS Consortium and three members from the EAB onsite: John Richards (EPRI, USA), Abhinav Gupta (NCSU CNEFS, USA), Tadeusz Szczesiak (ENSI, Switzerland). The plenary heard about progress from Work Packages and an overall project presentation from the coordinator as well as three technical sessions as well as an EAB meeting and feedback to the METIS Consortium and recommendations for final year of project.

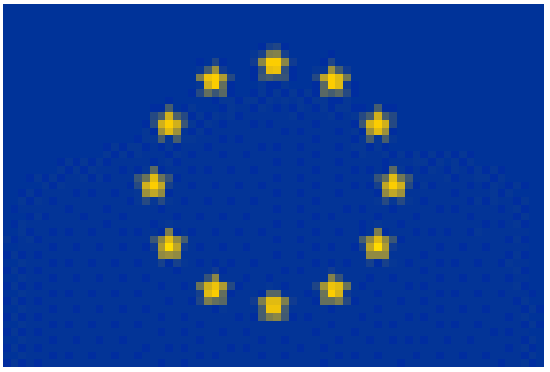
7 June 2024 / Workshop to Krško Nuclear Power Plant (KNPP) Ljubljana, Slovenia

The METIS project attended a workshop at the NPP attended by METIS Consortium partners, NPP representatives (two participants from SNSA, one from GEN, three from NEK, and four from the Ministry of Environment, Climate and Energy). A significant highlight of the site visit was control room simulator as well as being able to exchange on METIS developments and current practices with presentations from METIS and NPP engineering representatives (Irmela Zentner, Shadi Fathabadi, Marco Pagani, Matjaz Dolsek, Daniel Celarek).

Read the full article

3 - 8 March 2024 / SMIRT27 2024 Japan

METIS was present at the SMiRT 27 (Structural Mechanics in Reactor Technology) to share recent project results and developments with the nuclear community. The SMiRT 27 was held in-person in Yokohama, Japan. The conference is the major event for structural mechanics and earthquake engineering in the nuclear sector.



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