EGU26-16851, updated on 26 Mar 2026
https://doi.org/10.5194/egusphere-egu26-16851
EGU General Assembly 2026

From Current to Next-Generation NFOs: First-Year Achievements and Strategic Goals of the TRANSFORM² Horizon Europe Project

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Near-Fault Observatories (NFOs) are natural laboratories located at or near active faults undergoing complex geophysical processes, often in proximity to densely populated urban areas.

Covering relatively small areas, NFOs provide researchers from multiple disciplines (e.g., geophysics, geodesy, geochemistry) accessing rich, reusable datasets for generating scientific outputss. This enables improved understanding of the multi-scale physical and chemical processes driving earthquake generation—a goal achieveable only through continuous, long-term, high-resolution multidisciplinary data acquisition and consistent application of state-of-the-art processing techniques.

Eight NFOs in Europe have been identified by the European Plate Observing System (EPOS) as long-term Research Infrastructures (RIs); one additional is in observer status. NFOs aim to enhance

understanding of earthquake mechanics to unravel the anatomy of complex seismogenic faults.

The TRANSFORM² project has the ambitious goal of improving and transforming the existing NFOs, by integrating cutting-edge methodological and technological solutions, paving the way for the next generation of NFOs across Europe. This will be achieved by:

- Evaluating state-of-the-art sensors through testing, horizon scanning, gap analysis, and user needs assessment for NFO deployment.
- Accelerating development and field-testing of promising new sensors.
- Developping ML-powered workflows for real-time detection, location, and characterization of seismicity.
- Creating next-generation Earthquake Early Warning (EEW) paradigms, optimized for dense NFO networks and validating their societal impact.
- Strengthening stakeholder & decision-maker engagement by better understanding their needs and demonstrating clear benefits from NFO data/products.
- Positioning existing NFOs as open, high-quality test-beds for calibration and validation of new geophysical instruments and systems.
- Identifying sustainable funding pathways and providing recommendations to national authorities and the European Commission for long-term RI support.

Following the first year of the project, the design and testing of cutting-edge sensors, along with the development of automatic workflows for the detection and characterisation of seismic events and sequences, and the implementation of Earthquake Early Warning systems, are actively being carried out and extended to a growing number of NFOs. Concurrent deployment of the principal sensors, vital for supporting and enabling these advancements, is already in progress.

Finally, a 'white book' will be made public to document how data, products and services from the next-generation RIs can be exploited for the benefit of different target stakeholders, such as the research community, local authorities, and society, and to propose ways for ensuring sustainable funding of the RIs in the future.

TRANSFORM² is funded by the European Union under project number 101188365 within the HORIZON-INFRA-2024-DEV-01-01 call.

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