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

Panagiotis Elias[1], John Clinton[2], Simona Colombelli[3], Mariano Supino[4], Alexandru Marmureanu[5], Dimitris Paronis[6], George Kaviris[7], Efthimios Sokos[1], Vassilis Karastathis[6], Pascal Bernard[8], Gaetano Festa[3], Christos Evangelidis[6], Alessandro Vuan[9], Jan Kaplon[10], Vladimir Plicka[11], Semih Ergintav[12], Giovanni Costa[13], Stanka Šebela[14], Nikolaos Theodoulidis[15], Ilias Aliferis[16], and the rest TRANSFORM² team[*]

[1]University of Patras, Patras, Greece (pelias@upatras.gr)
[2]Swiss Seismological Service, ETH Zurich, Switzerland
[3]Università di Napoli Federico II, Naples, Italy
[4]Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy
[5]National Institute for Earth Physics, Bucurest, Romania
[6]National Observatory of Athens, Athens, Greece
[7]Section of Geophysics-Geothermics, Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, 15784 Athens, Greece
[8]Institut de Physique du Globe de Paris, Paris, France
[9]National Institute of Oceanography and Applied Geophysics – OGS, Trieste, Italy
[10]Wrocław University of Environmental and Life Sciences, Wrocław, Poland
[11]Charles University, Prague, Czechia
[12]Boğaziçi University, Kandilli Observatory and Earthquake Research Institute, Department of Geodesy, Istanbul, Türkiye
[13]University of Trieste, Trieste, Italy
[14]Research Centre of the Slovenian Academy of Sciences and Arts – ZRC SAZU, Postojna, Slovenia
[15]Earthquake Planning and Portection Organization, Athens, Greece
[16]Pleiades IoT Innovation Cluster, Athens, Greece
[*]A full list of authors appears at the end of the abstract

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.

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rest TRANSFORM² team: Men-Andrin Meier, Tomas Fischer and Lauro Chiaraluce