# Global cooperation in particle physics addresses global issues.

On November 23, 2023, the Springer Nature group features the topic of muography in Nature Reviews Methods Primers. Covering the most recent developments in muography, the article is written with the cooperation of a large team of International Muography Virtual Institute (VMI) researchers from universities/institutes in 12 countries including The University of Tokyo, The University of Salerno, Fermi National Accelerator Laboratory, The National Metrology Institute of Italy, National Institute for Astrophysics, Université catholique de Louvain, Durham University, Enrico Fermi Research Center, National Institute for Nuclear Physics, CERN, Muon Solutions, University of Oulu, Arctic Planetary Science Institute, Kyushu University, Laboratoire Souterrain à Bas Bruit, University of Atacama, Lanzhou University, The University of Catania, Institute of Physics of the 2 Infinities (IP2I), MUODIM, Lebedev Physical Institute, Andhra University, Federal University of Pernambuco, The University of Sheffield, and Wigner Research Centre for Physics.
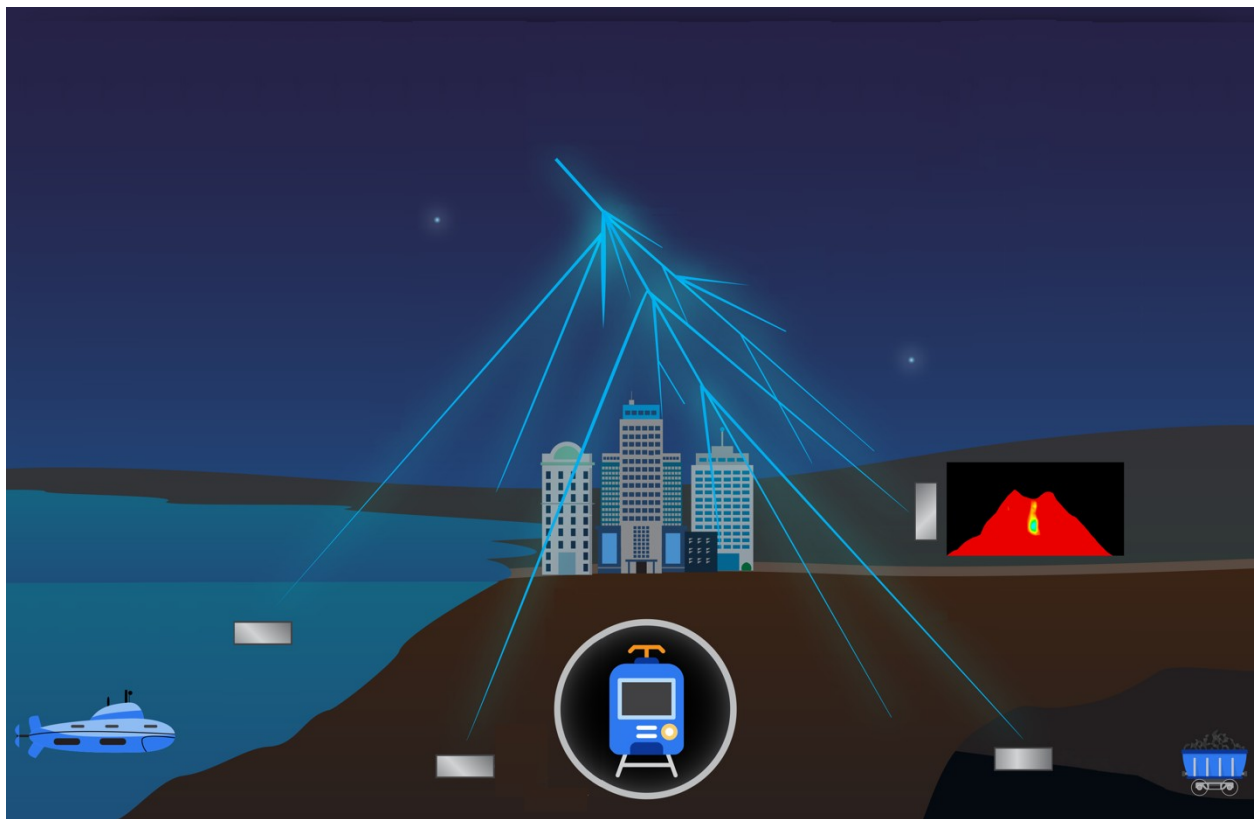
All aspects of muography along with the latest achievements, such as centimeter-level navigation with the indoor muometric position system (muPS) which is compared with other established PNT technologies, are comprehensively explained for students, academics and researchers along with descriptions of applications and experimental case studies. Other major topics described are muographic imagery used for visualizing the internal structure of gigantic objects, as well as muometric positioning, navigation, timing (PNT) that includes the techniques of the muometric positioning system (muPS), cosmic time synchronization (CTS) and cosmic time calibration (CTC) and

cryptographic applications with the cosmic coding and transfer (COSMOCAT) technique and encryption key storage (COSMOCATS).

Some specific examples of both established and new applications include visualizing the internal structure of volcanoes, tunneling and mining, pyramids, underground/underwater muPS navigation, near-field wireless security, cloud-based authentication systems and secured communications, precise time synchronization of secured wireless sensor networks. Developments in muography simulations and data analysis, image modelling and instrumentation are also covered.

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