ERMES, the new technique for earthquake forecast
(Earthquake Reconnaissance via Muon beam Evolution in Silicon dioxide)

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Abstract

ERMES is a new technique recently conceived (Ref. 1,2) for effective forecast of shallow earthquakes, based on active interrogation of tectonic stress active in regions of the Earth crust where active seismogenic faults can generate seismic events whose magnitude depends on the amount of stored energy in the crust elasto-plastic deformation. The new physical mechanism just discovered is the random-walk brownian motion of high energy muons propagating through the piezoelectric fabrics, made of quartz crystals abundant in granite-like rocks. The tectonic pressure activates piezoelectricity whose field amplitude scales linearly with applied pressure: this is responsible of the random walk effect on the muons crossing the Earth crust region of interest. The induced muon beam diffraction brings to the detector a signal scaling with the tectonic pressure, allowing to monitor the escalation of the rock elasto-plastic deformation toward the rupture limit. To run an ERMES system we need a compact 500 GeV (negative) muon accelerator, with the ease of low flux requests (10^8 muon/s) and large emittances (50 times larger than that requested by muon colliders, which also need 10^12 muon/s). The challenge to develop such a particle accelerator would be rewarded by making reliable earthquake forecasts a reality, helping to save human lives.

Recent Publications

1. *Physical Review Research* **7**, 043336 (2025)
2. *ArXiv preprint* arXiv:2601.10430 (2026)

Biography



Luca Serafini is an expert of high brightness beams, radiation sources (undulatory and collisional), tertiary beams, Full Inverse Compton Scattering, muon beams for seismology, muonic lenses. His principal scientific achievements and activities are: derivation of the RF Transport Matrix, the theory of invariant envelope and emittance compensation in photo- injectors, the velocity bunching technique, the two-way acceleration in ERLs, the EXMP technique for ultra-low emittance muon beams, the Full Inverse Compton Scattering, and ERMES, the new technique for active interrogation of seismogenic faults using high energy muon beams for earthquake forecast. Large scale (TWh) gravitational batteries are also in his present scientific interest. He is co-author of the ASFAP Unesco Report (African Strategy for Fundamental and Applied Physics).