A Strainmeter Array Along the Alto Tiberina Fault System, Central Italy

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The Alto Tiberina fault (ATF) in the Northern Apennines (Central Italy) is a low-angle normal fault (mean dip 20°) that is the target of TABOO (The Alto Tiberina Near Fault Observatory), a state-of-art research and monitoring infrastructure based on multidisciplinary sensors. With the STAR's project, we intend to deploy a strain- and seismo-meter array in six shallow boreholes to complement and enhance TABOO. This will happen with the active contribution of US National Science Foundation and International Continental Scientific Drilling Program (ICDP Project ID: ICDP-2018/05).

Existing seismic data from TABOO reveal microseismicity, at a consistently high rate on the ATF fault plane, including repeating earthquakes (RE). REs together with a steep gradient in crustal velocities measured by GPS and transient surface motion lasting for few months and coinciding with seismic swarms, support the hypothesis that portions of the ATF are creeping aseismically.

Recent studies document that any given patch of a fault can creep, nucleate slow earthquakes, and also host large earthquakes. Thus, these observations are forcing a revolution in our way of thinking about how faults accommodate slip. However, the interaction between creep, slow, and regular earthquakes is still poorly documented by observation. The ATF fault is perhaps the best place in the world to understand at local scale the mechanisms and implications of stress transfer process between seismic and aseismic fault segments. With STAR we will collect the Open Access data to illuminate the physics that allows for both seismic and aseismic slip on a single fault patch, with potentially transformational implications for seismic hazard and risk assessment globally.

STAR will consist of six 80-160m deep vertical boreholes covering the portion of the ATF that exhibits REs at shallow depth (~4 km), identified with waveforms analysis. The observatory will provide the international community an opportunity to study creep at local scale and over periods of minutes to months poorly constrained by other geophysical instruments. We will also deploy downhole seismometers and pressure transducers co-located with the strainmeters, and each station will be equipped with surface GPS and a meteorological instrument. The suite of instruments will enable the collection and calibration of strain records with exquisitely high precision, allowing for a quantitative characterization of ATF creep (~1mm over <1km2), enhanced monitoring of microseismicity (below Mc 0.5), and allowing correlation between degassing (CO2, Rn) measurements and subsurface strain.