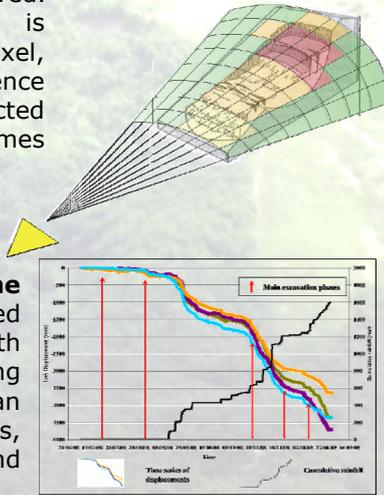


Technicians of **NHAZCA S.r.l.** (spin-off of "Sapienza" Università di Roma) have a wide experience in the field of natural hazards assessment and control. Since some years NHAZCA has been experimenting, in collaboration with **IMG S.r.l.** and the **CERI Research Centre** of "Sapienza" Università di Roma, the **TInSAR** technique for the monitoring of landslides. Several projects have been activated in last years involving NHAZCA S.r.l. to the monitoring of unstable slopes by **Terrestrial SAR Interferometry (TInSAR)** and **Terrestrial Laser Scanner (TLS)**.



SAR technique allows 2D images of the analysed scenario with a high range (instrument-scenario joining direction) and cross-range (orthogonal to the range direction on the horizontal plane) resolution to be achieved. The displacement is computed, for each pixel, by the phase difference of radar images collected at different times (**Interferometric principle**).

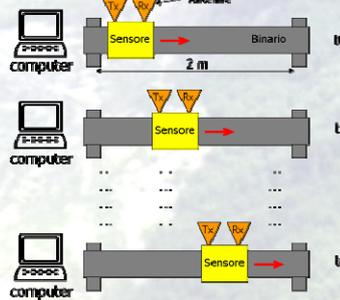
Displacement time series can be achieved and compared with landslide controlling factors such as: human activities, rainfalls, temperatures, ground water variations etc.



The displacement accuracy is on the order of millimetre or less than one mm, depending on the radar-target distance and on the atmospheric conditions. The TInSAR technique can continuously operate (24/7) in every weather and lighting conditions. Moreover, it is completely remote controlled (it does not require the installation of sensors or targets on the monitored slope). The sampling rate is about 5-6 minutes (i.e. a displacement map is automatically generated every 5-6 minutes).



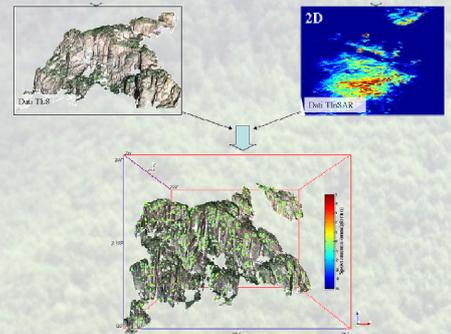
The **TInSAR operational principles** are similar to the satellite SAR Interferometry. The synthetic aperture is obtained by an antenna moving along a rail, instead of a satellite moving around an orbit.



TInSAR offers very short measurement time interval (i.e. few minutes) respect to satellite-based Interferometry (i.e. some days). However, a ground-based system (though with an operability range of some kilometres) has a very limited observation radius if compared to a satellite-based one.

Hence, TInSAR has a high potential for the study of individual landslides (or slopes which cover a limited area in the order of few kms) even if they are characterized by fast movements (up to 1-2 m/day).

NHAZCA S.r.l. performs **combined analysis** by TInSAR and TLS and developed a dedicated algorithm to overlap TInSAR maps on Laser Scanner images in order to achieve a perfect identification of the unstable portions of the slopes.



TInSAR technique has been successfully applied to the monitoring of different types of landslides and in different conditions such as: a) continuous control of landslides affected by human activities; b) landslide interacting with infrastructures; c) continuous control of rapid earth-flows; d) monitoring of rock scarps affected by rock falls and toppling.

This technique can be used for different purposes and in different stages of the landslides analysis: 1) identification of stability conditions of susceptible slopes (susceptibility analysis); 2) detailed areal mapping of already detected landslides; 3) continuous and real time monitoring for civil protection purposes.