# Terrain Measurement

**European PI(s)**
Prof. Fabio Rocca, rocca@elet.polimi.it

**Chinese PI(s)**
Prof. LI Deren, dli@whu.edu.cn

The aim of the proposed research is to take advantage of the increasing availability of EO SAR data in order to: i) achieve improved accuracy on already available SAR-derived products such as terrain topography and displacement; ii) extend the analysis by one dimension by providing three dimensional resolution capabilities.

The key for the achievement of the objectives above is the coherent combination of multiple passes through SAR Tomography (TomoSAR) techniques, which allow to focus the signal in the three dimensional space. Hence, the possibility arises to distinguish targets at different elevation within the same range-azimuth resolution cell (lay-over). As a result, target features such as height, backscatter coefficient, and motion over time can be investigated in the three dimensional space.
This way of proceeding is expected to provide substantial improvements in cases where the widely retained assumption of stable and point-like targets breaks down, that is in natural scenarios, where the signal from the terrain is disturbed by vegetation, and dense urban environments, for which lay-over phenomena are likely to occur.

The range of applications enabled this approach would include:

- terrain topography mapping in presence of vegetation
- estimation of soil scattering in presence of vegetation
- surface elevation mapping of the vegetation cover
- mapping of ice thickness and ice flow
- subsurface mapping in arid zones (whenever permitted by wave penetration)
- improved differential interferometric analysis in natural areas (ground subsidence)
- three dimensional mapping of urban areas
- differential interferometric analysis in three dimensions (deformations of buildings, bridges, and dams)

The proposed research is expected to bring significant advancements concerning the exploitation of SAR data stacks, resulting in improved interferometric analyses in case of surface-like scattering as well as the definition of new products concerning volumetric targets.

Expected results concerning final (Level-2) products can be summarized as:
*DinSAR:*

- Improved detection/estimation capabilities in multi-pass over distributed/decorrelating targets
- Comparison of results obtained at different frequency bands (L-, S-, C-Band, X-Band) through the exploitation of PALSAR, HJ-1C, Sentinel-1, and COSMO data.

*TomoSAR:*

- Terrain topography and backscatter coefficient mapping in presence of vegetation
- Vegetation mapping (surface height)
- mapping of ice thickness and ice flow
- three dimensional mapping of urban areas
- differential tomographic analysis in urban areas

# 地形测绘

**欧方负责人**
Fabio Rocca, rocca@elet.polimi.it

**中方负责人**
李德仁， dli@whu.edu.cn

本项目的主要宗旨是利用不断增多的对地观测SAR数据，提高已有地形测量产品和形变监测产品的精度，拓展现有二维分析方法，实现三维分辨能力。

达到上述研究目标的关键是采用多基线SAR数据相干层析技术，在三维空间中实现SAR信号聚焦。多基线SAR相干层析技术可以克服叠掩效应影响，分离单个分辨单元内可能存在的位于不同高度的多个散射体目标，提取各目标的高度、散射系数及三维运动参数等信息。在有植被覆盖的自然场景和叠掩效应严重的城市复杂场景中，目前常用的稳定点目标分析法通常无法获得可靠的分析结果，而多基线SAR相干层析技术可大大改善这两种区域的分析结果。

该技术的潜在应用领域包括如下几个方面：

- 植被覆盖区域地形测绘
- 植被覆盖区域土壤散射特性估计
- 植被高度测绘
- 冰流及冰层厚度测绘
- 干旱地区地下结构测绘（当微波穿透干旱地表时）
- 自然区域地表沉降差分干涉分析改进
- 城市区域三维测绘
- 建筑、桥梁、大坝等目标的三维形变分析

该项目研究将极大提高SAR数据集的利用率，改善表面散射目标干涉分析结果，定义体散射目标分析新产品。预期研究成果及最终产品如下：

*DinSAR:*

- 改进的非相干目标/分布式目标区域形变监测能力
- 通过分析不同数据源（PALSAR，HJ-1C，Sentinel-1，和COSMO），比较不同波段((L-, S-, C-, X-波段)的形变监测结果

*TomoSAR:*

- 植被覆盖区域地形测绘及后向散射系数估计
- 植被测绘（表面高度）
- 冰流及冰层厚度测绘
- 城区三维测绘
- 城区差分层析分析