



## **Landslide ground based remote sensing monitoring: Formigal case study (Huesca, Spain)**

G. Herrera (1), D. Ponce-de-León (1), J. Mulas (1), M. Llorente (1), J. Hervás (1), G. Luzi (2), D. Mecatti (2), L. Noferini (2), G. Macaluso (2), M. Pieraccini (2), A. Tamburini (3), P. Federici (4).

1. Recursos Minerales, Riesgos Geológicos y Geoambiente, Instituto Geológico y Minero de España, (IGME), Spain (g.herrera@igme.es/ Fax: +34 91 349 5834)
2. Dept. of Electronics and Telecommunications (DET), University of Florence, Firenze – Italy (guido.luzi@unifi.it/ +39 055 4796750).
3. B.U. Strutture e Rischi Naturali, CESI S.p.A., Milano, Italy (andrea.tamburini@cesi.it / +39 035 557-7999).
4. Dipartimento Ambiente e Sviluppo Sostenibile, CESI RICERCA S.p.A., Milano, Italy (paolo.federici@cesiricerca.it / +39 02 3992-4608).

Galahad is an ongoing Specific Targeted Research Project developed within the EU 6th Framework Programme – Priority 1.1.6.3. The objective is to retrieve, through the use of improved GB-SAR and TLS technologies, field parameters that can be used in prediction algorithms of landslides, avalanches and glaciers related hazards. The landslide study area is located in the ski resort of Formigal, central Pyrenees (province of Huesca, Spain). The excavation of a parking area in the summer of 2004 reactivated a complex paleolandslide creating new sliding surfaces. The movement extends over an area of 0.25 km<sup>2</sup> and experienced displacements as large as 0.5 cm/day during the period 2004–2005. Stabilization engineering solutions were carried out reducing maximum observed displacement to 0.2 cm/day at the end of 2005. Within Galahad performed activities consisted in the collection of data on the landslide useful for its detailed characterization and the execution of a series of site measurement campaigns with GB-SAR, TLS and Differential GPS (D-GPS). The monitoring activities started in May 2006 completing a series of four campaigns with Total Station and D-GPS, a continuous two month data acquisition with GB-SAR and several TLS scans during two different periods from three points of view over the landslide. In this paper data

obtained by GB-SAR and TLS are compared with D-GPS data, and a good agreement has been found between data sets. The project is still in progress and new site measurement campaigns with GB-SAR, TLS and D-GPS in 2007 will provide further insight into landslide forecasting models.