Introduction
Spaceborne Differential Interferometric Synthetic Aperture Radar (DInSAR) is a remote sensing technology based on the measure of the phase of a radio wave reflected by ground scatterers. Exploiting the phase’s difference of those ground scatterers detected by two radar satellite acquisitions at two distinct times allows to detect the small deformations of the topography which occurred between the temporal baseline (Massonnet & Feigl, 1998).

Limited by atmospheric artifacts and decorrelation problems, DInSAR is more effective in urban, arid or rocky areas than in forest or cultivated areas. But it can detect quasi-vertical movements covering very large areas in a continuous way. That is why DInSAR can be considered an efficient tool to detect and monitor slope instabilities (Berardino et al., 2003).

Robovec™ system, exploited by the Soil Mechanics Laboratory of the Swiss Federal Institute of Technology of Lausanne, monitors ground displacements every 2h by a laser total station since summer 2006. In the summer 2007, a crisis period has been observed, triggered by very important rainfall.

Results
In the landslide, only areas covered by pastures have high coherences and consequently results. Furthermore, in the bottom of the instability, measurements are important and create strong geometrical decorrelations.

Conclusions
The results of this study are coherent with the amplitude of the deformations monitored by the software GSAR. However, the computation of the mean velocities shows that today, total displacements are measured in the active lower part of the landslide; the data complete Robovec™ results.

The accuracy of the measured displacements and the number of scatterers could be improved by synthesizing topographic phase from an aerial laser scanning device instead of the SBAS. The number of scatterers can also be increased by installing corner reflectors in the fastest-moving area of the landslide.

When archives of Alos PALSAR scenes will be more complete in the Alps, it will be interesting to use those L-band images to process SBAS, reducing artifacts and decorrelations.

As soon as the construction of the drainage gallery finished, it will be interesting to monitor the subsidence areas by SBAS to control the efficiency of the gallery.

Figure 2: Orthophoto of the La Frasse landslide area

Figure 3: Orthophoto of the La Frasse landslide area

Figure 4: Geomorphology of the La Frasse landslide, detectable with an aerial laser scanning device

Figure 5: Geomorphology of the La Frasse landslide

Figure 6: Mean ground displacements monitored by Robovec™ system. With more than 80cm for the prism 8, annual displacements are decimetric.

Figure 7: Left: Coherences Map. Right: Mean relative velocities map. Resolution: 60x60m. Projection: CH1903, LV03. Software: GSAR™ (Norus) & ArcGIS™ (ESRI). Actor: swisstopo CH-AGA04.

Figure 8: Reversed projections

Figure 9: Mean velocities in the slope. Resolution: 60x60m. Projection: CH1903, LV03. Software: GSAR™ (Norus) & ArcGIS™ (ESRI). Actor: swisstopo CH-AGA04.

Input and Processing
To acquire the Radar dataset, the project ‘Differential Synthetic Aperture Radar (DInSAR) interferometry in monitoring large landslides in La Frasse’ was concluded with the European Space Agency.

> 24 Envisat ASAR scenes - Track 2; Frame 2573; Descending orbits - From October 2002 to November 2008 (snow free period)

The Small Baseline Subset (SBAS) can process mean annual velocities of distributed scattering pixels and filter out artifacts due to atmospheric disturbances (Lausen, 2004). The software GSAR developed by Norut Tromsø was used.

> 53 pairs processed - Maximum temporal baseline: 400 days - Maximum normal baseline: 300 m - DEM used: SRTM 90m

Geomorphology
According to Varnes classification, the La Frasse landslide is a complex slide composed of tertiary flysch material and flowing on flysch and limestone bedrock (Bonnard & Noverraz, 1986). According to Varnes classification, La Frasse landslide is a highly hazardous landslide affecting some habitations and two main roads to touristic areas. At present, a drainage gallery is being constructed under the active part of the landslide.

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Figure 1: Influence of a landslide on the phasic difference

Figure 2: Green star locates the La Frasse landslide (Suissepto)