# Leica GPS Spider for Deformation Monitoring


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## Introduction

Leica Geosystems has for a long time recognized the need to combine various surveying instruments and sensors when designing solutions to monitor man-made infrastructure as well as natural disasters.

With the well-accepted use of GPS in that field of application today, Leica Geosystems has recently developed an extension to its GPS SPIDER software to address this demand.

Supporting both single and dual frequency GPS receivers, this new approach consists of a regular download of observations into an automatic processing based on the Leica SKI-Pro software to produce the associated time series results in near real time. The latest release of this processing software also includes the possibility to process the data at each single epoch and to align the processing with sidereal time to mitigate the multipath effects.

Graphical displays and data analysis routines were developed to help those responsible for such monitoring projects to make informed decision in case of any alarming situations.

As well as Leica GeoMoS, which provides a combined solution of GPS and terrestrial sensors, the combination of GPS Spider together with SKI-Pro scripting allows the usage of single-frequency sensors in addition to powerful sensor configuration and RINEX storage for post-processing purposes.

Using the example of a recent installation, this poster describes the architecture and benefits of this solution.

## An installation example - the Eiblschrofen rock fall

On 7 July 1999, the ‘Eiblschrofen’, a rockface above the town of Schwaz in Austria, experienced significant geological movement, causing huge boulders to crash down into the valley (Fig. 1). Parts of the town had to be evacuated due to the considerable danger for the inhabitants and immediately following the evacuation, an intensive monitoring system was established in order to assess the ongoing movements of the rockfall area.

The local surveying company Weiser-Kandler was given the task for making daily measurements. After some time, when a noticeable decrease in the movements was detected, a huge dam was erected to provide future protection to the inhabitants who were then allowed to return to their homes.

The tension further relaxed, and the measurement interval was reduced to four months. In the summer of 2003, it was decided to review the monitoring program to get a clearer picture of the still ongoing, creeping movements of the Eiblschrofen. As part of this project, Weiser-Kandler and OPH installed a continuous GPS monitoring system.


Fig 1: Eiblschrofen rock face after the collapse

Fig 2: Monitoring point close to the rock face

**Eiblschrofen project overview**

- **Massive rock fall in `99, endangering inhabited areas below**
- **GPS and terrestrial campaigns started after the event**
- **Installation of permanent GPS monitoring with Spider in `04**
- **4 L1 sensors with WLAN link to processing center**
- **Fully automated baseline processing**

Fig 3: WLAN repeater

The large size of the deformation area, as well as dense vegetation and difficult terrain did not allow monitoring using total stations only (Fig. 2). Consequently, the surveying companies and their client, the township of Schwaz, agreed to establish a pure GPS monitoring network, which would run continuously, providing 24/7 coverage of deformation control. To solve this application challenge, two solutions were examined: Leica’s GeoMoS monitoring platform, or a combination of GPS Spider with SKI-Pro scripting. After discussions, GPS Spider with SKI-Pro scripting was chosen, one reason being that it was clear from the very beginning that the system would remain a GPS-only setup meaning that the sophisticated GPS-TPS combination that GeoMoS allows was not needed. On the other hand, short baselines and long processing intervals allowed the usage of single-frequency sensors. In addition, there were only limited requirements for analysis tools, which favoured the customized SKI-Pro scripting solution.

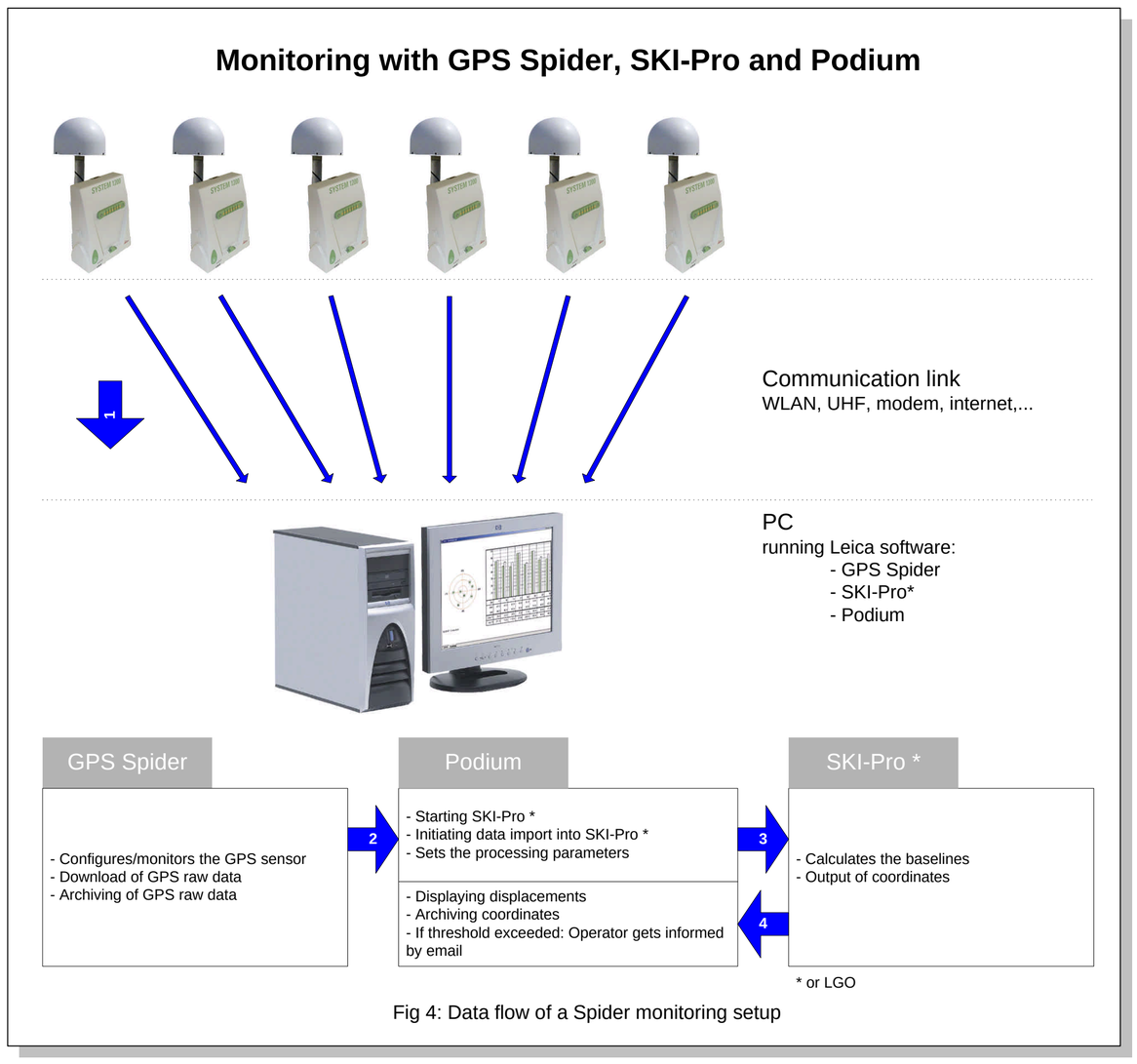


Fig 4: Data flow of a Spider monitoring setup

The final setup consisted of Leica GPS Spider software (Fig. 5) controlling SR510 sensors for the monitored points, as well as an RS500 on the control point. The communication between the PC in the data center and the reference stations, uses the latest WirelessLAN technology over a distance of a few kilometres (Fig. 3). Spider automatically downloads raw measurement data files from the sensor every twelve hours, and archives them to the processing PC. The GPS processing is completed by SKI-Pro and steered by the VisualBasic application ‘Podium’(Fig. 4). Podium makes use of SKI-Pro’s scripting capability and automatically imports the data into SKI-Pro, controls the processing and exports the data to customized ASCII files. Furthermore, it shows both graphically and numerically the recorded movements and informs via email if any threshold is exceeded (Fig. 6).

The system went operational in November 2003, and since then, has been providing seamless deformation data, which is vital for the comprehensive analysis of the geological processes at Eiblschrofen. Furthermore an additional use of the station as RTK base station equipped with the dual-frequency and RTK-enabled RS500 is planned. After attaching a proper communication device such as a modem to the reference station, and using Spider, the sensor can be remotely configured to send RTK corrections at the touch of a button.

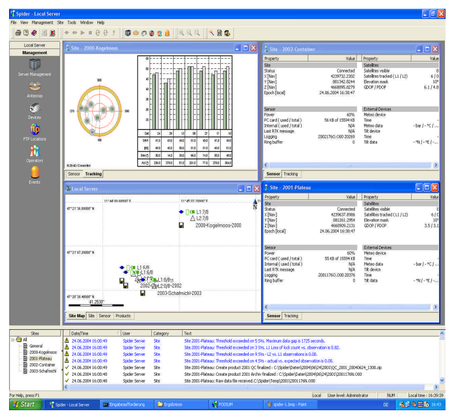

Fig 5: GPS Spider sensor status view

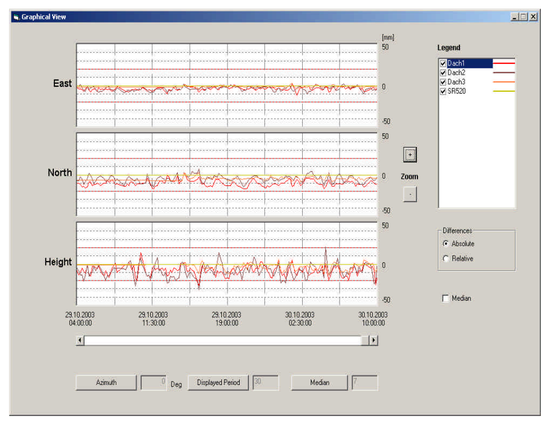


Fig 6: Podium result display


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**Benefits of Monitoring with GPS Spider**

- **Scheduled post-processing for reliable results under difficult tracking conditions**
- **Use of L1 Sensors**
- **Additional use of master reference station as RTK base**
- **Fully automated**
- **Off-the-shelf components for receiver management and processing**
- **VisualBasic application (Podium) for customization of data storage and analysis**


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