

Corner Reflector Interferometry (CRInSAR) is ideal for monitoring the displacement of engineered structures such as reservoirs, dams, pipelines, railways, bridges, canals, roads, docks, airports, individual buildings, or suspected areas of instability, e.g. across geological faults and unstable slopes. NPA are pioneering the use of artificial radar reflectors that can be installed on the structure or ground to be monitored. This is often necessary in target areas that have no pre-existing natural or artificial structures that can serve as suitable radar reflectors.

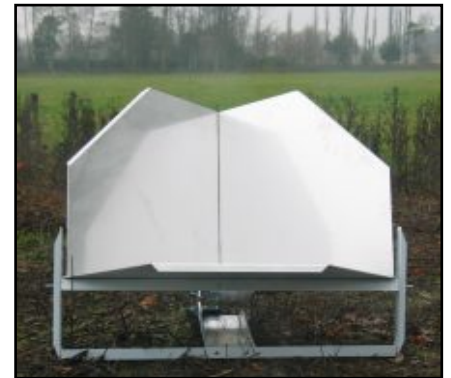


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Such a monitoring system has great advantages especially for remote areas, where mobilisation and access costs are high. The time-frame over which motions can be monitored and measured is highly flexible and can range from the satellite unit repeat period of 3 or 5 weeks up to several months or years.

The technique requires the installation of trihedral metallic corner reflectors (CRs), 80cm each side, that are physically anchored to the structure or ground to be monitored. The CR guarantees a clear, strong and time persistent target response to the satellite radar sensor at every orbit pass (once per month). The CRInSAR product comprises the measured displacement at CR locations from one scene acquisition relative to another in tabular form.

Corner Reflectors (CRs) are deployed in cluster arrays of 10 to 15 units. CR layout can be chosen by the user but is constrained to a minimum separation of 100m between CRs and a maximum distance of 750m of each CR to the associated reference (stable) CR. CRs require specialist installation to be accurately oriented towards the satellite and the satellite mode chosen (ascending or descending orbit).



Photograph copyright NPA Group 2005

NEW - NPA are trialling Compact Active Transponders (CATs), which perform the same function as passive CRs, but in a different manner: when illuminated by the radar beam from the satellite sensor, the CATs respond by actively emitting a similar (invisible and inaudible) signal that is received and recorded by the satellite. In comparison to CRs, CATs are more compact and less obtrusive (see figure). Being sensitive to both ascending and descending radar satellite (Envisat-ASAR and Radarsat) modes, potentially increases the frequency of motion measurements by a factor of four. In addition CATs have a wider field of view than CRs, so that highly accurate orientation upon installation will not be required. CATs are currently undergoing validation field tests.



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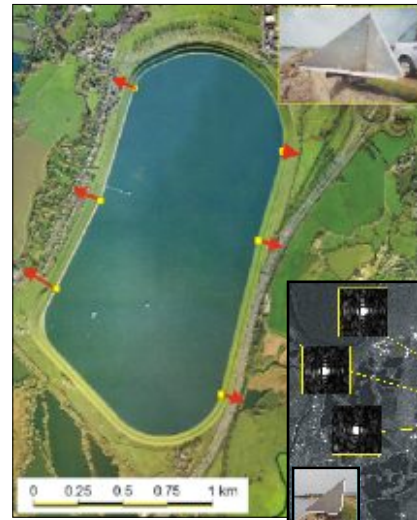
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Case Study 1: Major water reservoir, UK

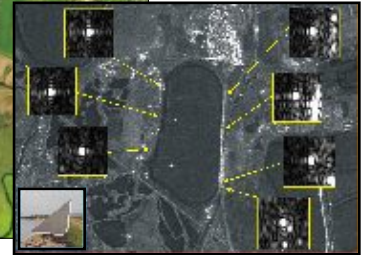
In a project funded by the European Space Agency, NPA was working with Thames Water, the world's third largest water company, using corner reflector interferometry to monitor the displacement of retaining banks associated with water volume in their London reservoirs.

Six inexpensive one-metre reflectors were secured around a major reservoir perimeter to detect and monitor side-wall deflections as the reservoir fills and empties. One unit was sited on stable ground as control. The image shows the locations of mounted corner reflectors (inset) in yellow at the reservoir, together with InSAR-measured wall deflections as scaled red arrows. Largest movements amount to a few millimetres.



Background reservoir air photo copyright Cities Revealed 2001.

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Case study 2: Highway, UK

Validating known subsidence in a historic mining excavation area

The main image shows CAT units in operation along a stretch of UK highway. The unit responses are seen as bright lobes in the radar image, which has been overlaid on aerial photography.



Photograph of a CAT adjacent to the highway being studied as part of the validation exercise.

Photograph copyright NPA Group 2005

The image highlights the benefit of using the equipment in areas where little or no natural reflectors exist. The area of study is prone to subsidence due to historical mining excavation.

The site was chosen as part of a validation exercise in which the CATs are being trialled.

Technical specifications for CRInSAR:

Potential area coverage	Worldwide
Data sources	SAR (Synthetic Aperture Radar) data acquired by ERS-2 and Envisat (operated by ESA) or Radarsat (operated by RSI)
Measurement direction	Sensor line-of-sight (variable for Envisat)
Sampling interval	Every 24 days with Radarsat or 35 days for Envisat (single mode)
Relative movement resolution	Unambiguous consistent movements of the order of 1.5cm (resolved vertically) should be detectable
Relative movement accuracy	Sub-centimetric, depending on parameters such as atmospheric conditions and local topography
Elevation precision	Better than 1m (improved by initial GPS surveying)
Relative spatial accuracy	+/- 5m in E-W, +/- 3.5m N-S (improved by initial GPS surveying)
Absolute spatial accuracy	20m (3m if ascertained by GPS surveying)



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