

Ground for development

26 April 2019

The Gravity Pioneer project aims to improve the way we detect and monitor objects below the ground, in turn reducing the risks and costs of development, writes George Tuckwell

Our ability to detect and monitor objects on land, in the sea, around buildings or in space has been enhanced in recent years, yet our ability to detect those beneath the ground has not improved significantly. When attempting to locate a forgotten mineshaft, determine the extent of a sinkhole or assess the quality of infrastructure, we still often resort to digging or drilling holes.

This is costly as road networks are dug up, oil wells are drained and brownfield land is left undeveloped, which affects project risk, cost and timescales and contributes to some of the main reasons for project delays: poor planning, lack of information and changes to specifications.

Existing ground investigation techniques include ground-penetrating radar, classical microgravity and seismic technologies, but these can be limited in sensitivity or depth penetration. For more than 30 years, academics have therefore been exploring the effects of quantum superposition to measure gravity with significant sensitivity.

Using a process called cold-atom interferometry, the wave?particle duality of a rubidium atom is compared with the phase of a laser beam to detect minute changes in the way other atoms fall freely in a vacuum. Changes in this freefall can be used to determine the local strength of gravity. If this measurement is sensitive enough it can be used to tell whether there are voids, pipes, tunnels or oil or gas reserves in the ground beneath your feet.

A group of scientific and engineering companies has joined forces with universities and organisations currently engaged with quantum technologies in the UK for the [Gravity Pioneer](#) project. The aim is to develop a tested blueprint for a commercially viable gravity instrument. Environmental and engineering services company [RSK](#) is leading 12 project partners, including component manufacturers, instrument developers and users, covering the supply chain of service providers and instrument and component manufacturers.

The prominent role of end users in the project was a large factor in its successful bid for ?6m in research funding from [UK Research and Innovation](#) , announced at the [National Quantum Technologies Showcase](#) in November 2018. The money comes from the ?20m Quantum Technologies Pioneer Fund, which aims to develop prototypes that could be used in future sensors, consumer electronics and digital services over a 2-year time frame.

With this funding, the project will now begin work on a prototype that aims to achieve a 2-fold sensitivity improvement and a 10-fold measurement speed improvement over the industry-standard gravity sensor. To do this, the team will be looking at:

- removing systematic measurement errors in presently used devices;
- investigating and implementing new schemes for creating and manipulating cold atoms to improve the signal-to-noise ratio;
- improving component performance; and
- addressing key supply-chain risks in certain components such as laser systems.

The aim is to have a working prototype in the field in 1 year, which will be refined over the following 18 months to improve its practical performance.

Once the advanced performance of quantum cold-atom sensors is demonstrable, the economic and societal benefits will be significant. Principal designers, project managers and quantity surveyors will have access to a technology that provides unprecedented images of the subsurface, thereby significantly reducing the risk of unforeseen ground conditions affecting project costs and programmes.

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Further information

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- This feature is taken from the RICS [Construction journal](#) (April/May 2019)
- Related categories: [Planning and development](#)