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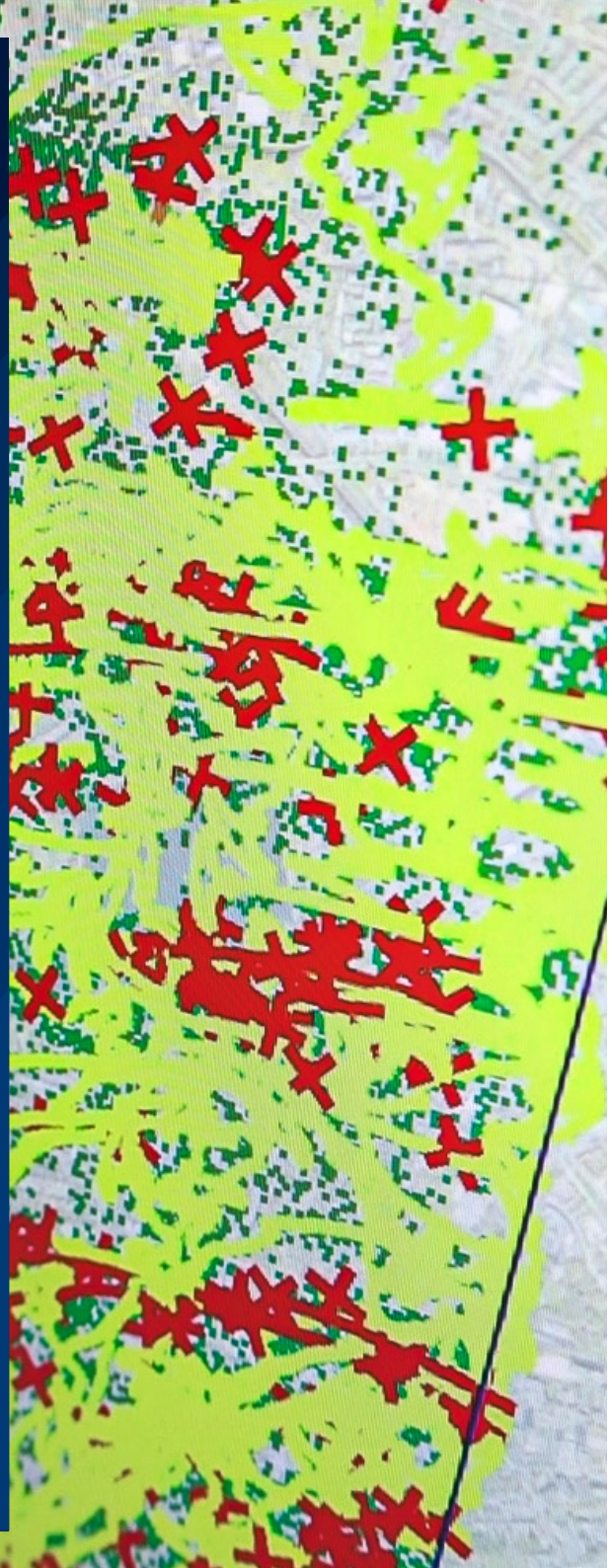
Make ideas real

QUANTUM-ENABLED RADAR RESEARCH

Finding the right solution for the University of Birmingham

AT A GLANCE

- **Customer:** University of Birmingham, UK
- **Task:** assisting UK Quantum Technology Hub research to develop high-precision radar for detecting small objects such as drones and birds
- **Challenge:** ensuring high-precision measurement of the oscillators forming the basis of quantum clocks
- **Solution/product**: R&S®FSWP phase noise analyzer and VCO tester
- **Key benefits**: the Rohde&Schwarz solution enables the University of Birmingham research team to create a benchmarking process for their own oscillators; precise, fast and repeatable calculations speed up the research process



Situation and requirements

When the UK Quantum Technology Hub needed high-precision quantum clocks, they turned to Rohde&Schwarz for test and measurement expertise.

Led by the University of Birmingham, the UK Quantum Technology Hub's Sensors and Timing project develops quantum clocks for precision radar and other applications such as map-matching navigation and gravitational sensing. The Universities of Glasgow, Strathclyde, Sussex, Imperial College London, Nottingham and Southampton are also partnering in the work, as are the National Physics Laboratory (NPL) and the British Geological Survey (BGS).

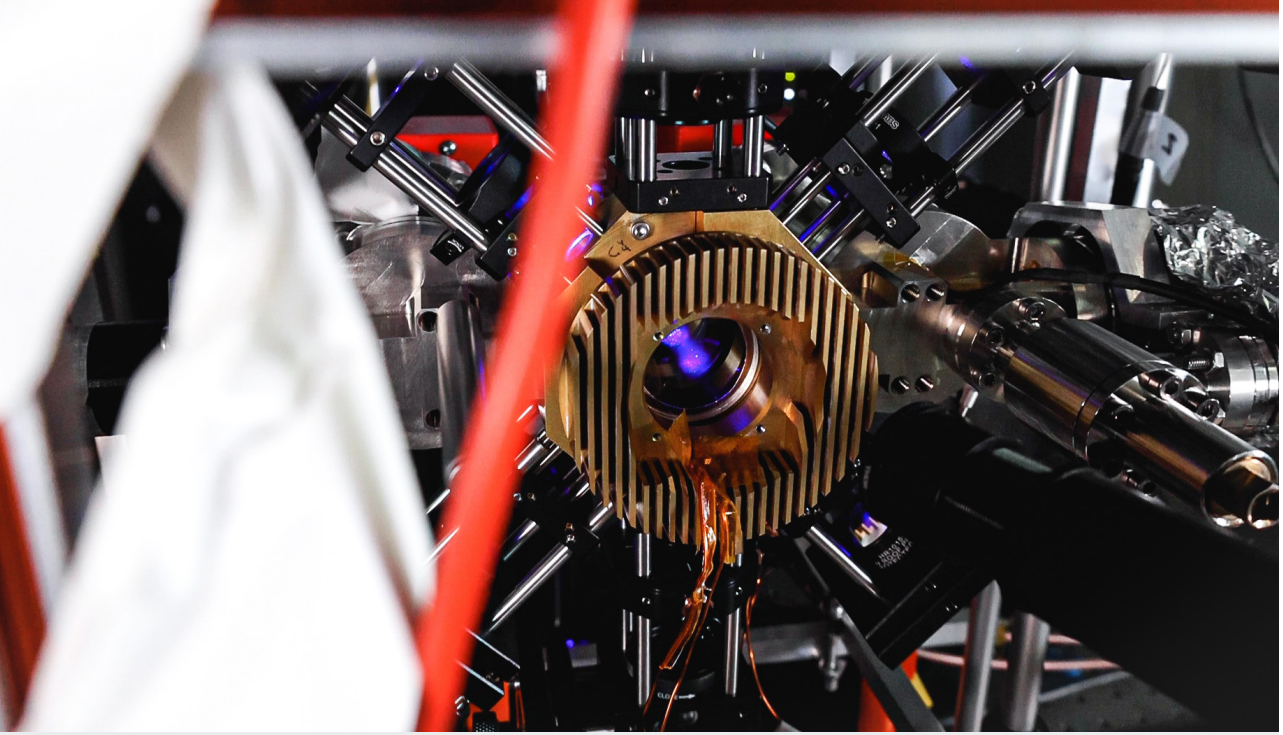
The goal of the UK Quantum Technology Hub is to develop high-precision radar to detect relatively small, slow-moving objects such as drones and even migrating birds. Whereas conventional radar technology struggles with this task due to its limited resolution and inability to capture identifiable images in sharp focus, quantum technology promises better results but requires high precision. This is where Rohde&Schwarz expertise comes in.

To assess their quantum clocks, the team needed to measure the performance of high precision oscillators on which the quantum clocks are based. The research team is engineering precision quantum oscillators to provide clean, sharp timing signals at frequencies up to 10 GHz.

Since quantum clock technology is based on high-precision instruments, it is important to ensure their accuracy with thorough testing using instruments capable of matching the precision of the radar.

For this purpose, the team selected the R&S®FSWP phase noise analyzer and VCO tester. The team selected this solution as their go-to instrument for its capability to take very high sensitivity phase noise measurements on various types of signals, including pulsed signals, which made it ideal for the task.

For more information, visit
www.rohde-schwarz.com



The image shows the strontium optical lattice clock under development at the University of Birmingham. Lasers and magnetic fields cool the atoms to a temperature a fraction above absolute zero and trap them inside a vacuum chamber. This allows the researchers to probe very precise transitions between energy levels in the strontium atoms, which provides the frequency reference for the optical atomic clock.

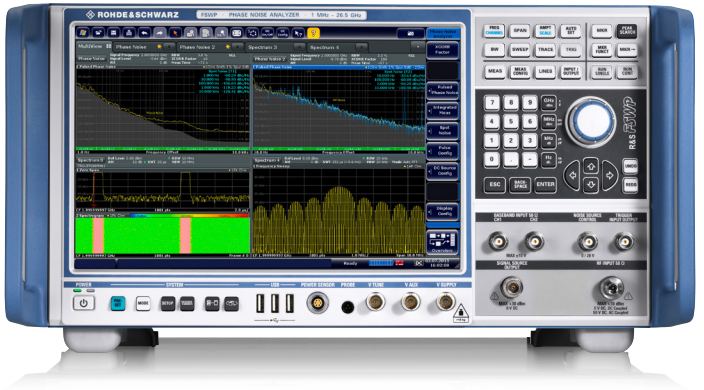
A powerful, easy to use solution supporting research

The R&S®FSWP helped the research team capture the required results quickly, while its high accuracy and repeatability lets them benchmark the performance of their oscillators as they continue to develop and improve them. The noise floor can be accessed without having to do additional averaging calculations.

An added benefit of the R&S®FSWP is its ease of use. The team simply plugs the oscillators into the solution, and lets its automated features do the rest.

"The R&S®FSWP helps us capture the results we need quickly. Its high accuracy and repeatability let us benchmark the performance of our oscillators as we continue to develop and improve them."

Dr. Jonathan Jones, Research Fellow, University of Birmingham School of Physics and Astronomy



R&S®FSWP

- High-end signal and spectrum analyzer and phase noise tester in one box
- Very high sensitivity for phase noise measurements even on pulsed signals through cross correlation with unrivaled performance close to carrier
- Frequency range of 1 MHz to 50 GHz, 500 GHz with external mixers

Rohde&Schwarz solution

To address the high-precision requirements of their task, the team acquired the R&S®FSWP phase noise analyzer and VCO tester through the Rohde&Schwarz University Support Program. The R&S®FSWP is particularly well suited for radar development and is capable of measuring very low noise levels in the 10 MHz to 20 GHz frequency range the University's experimental clocks operate in. Among its key features are very high sensitivity for phase noise measurements on various types of signals including pulsed signals, as well as its input frequency range of 1 MHz to 50 GHz, which can be extended to 500 GHz with external mixers. The R&S®SMA100B is also used in their research along with a Hydrogen maser reference signal in order to produce pure high stability frequency counter measurements.

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