DIAMOND LIGHT SOURCE MAKES THE INVISIBLE VISIBLE WITH A LITTLE HELP FROM ROHDE & SCHWARZ

Diamond Light Source

At a glance

By using synchrotron light channeled into multiple beamlines, researchers at Diamond Light Source are able to complete experiments using submolecular research on various items and objects ranging from fossils to jet engines, viruses and vaccines.

Education and outreach are an important part of the facility's activities, yet it is not so easy to explain, simply and safely, the nature of a high-intensity 2 kW X-ray beam to groups of visitors such as school parties. By creating a Visible Synchrotron Radiation (ViSR) beamline at 20 µW and using an oscilloscope, it enables demonstrations to take place in the visible spectrum.

Executive summary

- **Customer**: Diamond Light Source
- **Task**: Creating visible wavelengths for high-speed demonstrations of an invisible phenomenon
- **Solution/product**: R&S®RTA4004 oscilloscope
- **Key facts**:
  200 MHz to 1 GHz bandwidth,
  up to 5 Gsample/s sample rate,
  up to 1 Gsample memory depth,
  10 bit ADC resolution,
  10.1" capacitive touchscreen, four channels
- **Benefits**: User-friendly, easy-to-show demonstrations, latest connectivity options including remote control

Case Study | Version 01.00

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Make ideas real

About Diamond Light Source

Diamond Light Source, located on the Harwell Campus near Didcot, Oxfordshire, is the UK's national synchrotron; a not-for-profit research institute that is free at the point of access for the general scientific community, provided results are published in scientific literature. It works like a giant microscope, harnessing the power of electrons to produce bright light that scientists can use to study anything from fossils to jet engines to viruses and vaccines.

The machine accelerates electrons to nearly the speed of light so that they give off light 10 billion times brighter than the sun. These bright beams are then directed off into laboratories known as 'beamlines'. Here, scientists use the light to study a vast range of subject matter, from new medicines and treatments for disease to innovative engineering and cutting-edge technology.

Whether the objects under examination are fragments of ancient paintings or unknown virus structures, at the synchrotron scientists can study their samples using a machine that is 10 000 times more powerful than a traditional microscope. As an electron accelerator, with a circumference twice as long as London's iconic skyscraper The Shard, the instrument generates an extremely intense light source containing wavelengths from X-rays to infrared. How intense? The 2 kW X-ray beamline is about one hundred billion times more powerful than the machines you might encounter in a hospital or at the dentist. The synchrotron light is channeled into multiple beamlines that scientists can use for various types of experiments. In total, there are 39 instruments offering various beam sizes, energy levels and wavelengths.

Diamond is one of the most advanced scientific facilities in the world, and its pioneering capabilities are helping to keep the UK at the forefront of scientific research. So far, projects have included peering inside dinosaur eggs, analyzing the foot and mouth virus, gathering insights on radioactive fallout particles, studying the degradation of irreplaceable old-master paintings, cancer research, advanced battery research, and many other analyses that require submolecular or atomic resolution such as researching technologies for recycling and clean growth.

Diamond is a not-for-profit limited company funded as a joint venture by the UK Government through the Science & Technology Facilities Council (STFC) in partnership with the Wellcome Trust. The synchrotron is free at the point of access through a competitive application process, provided that the results are in the public domain. Over 7000 researchers from both academia and industry use Diamond to conduct experiments, assisted by approximately 620 staff. Diamond hosts regular visits from the public, schools, scientists and politicians.

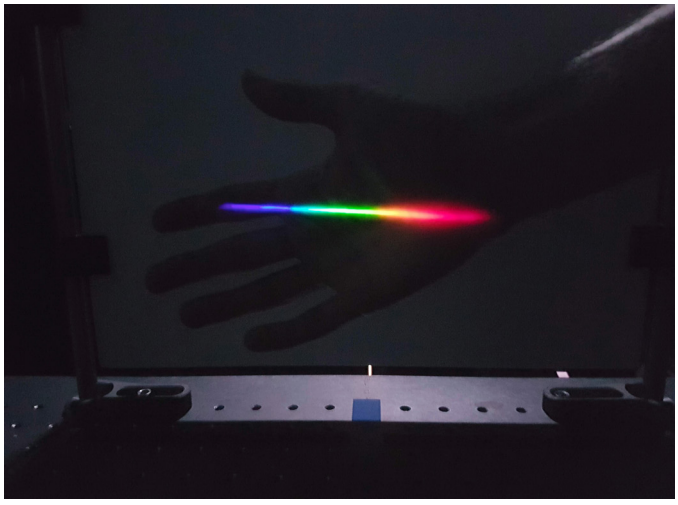
An R&S®RTA4004 1 GHz oscilloscope is helping reveal the mysteries of submolecular research for visitors to Diamond Light Source at Harwell in Oxfordshire.

The task

Given the nature of the facility and its funding model, being largely government backed, education and outreach are an important part of Diamond's activities. Visitors can experience a guided tour and see inside the synchrotron and laboratories when in shutdown. But it's not so easy to explain, simply and safely, the nature of a high-intensity 2 kW X-ray beam to groups of visitors such as school parties.

For this, the team at Diamond has created the Visible Synchrotron Radiation (ViSR) beamline, which can be visited while the synchrotron is operational, opening up new opportunities to expand and consolidate their visitor program. At a mere 20 µW, ViSR is safe to observe and the visible wavelengths are used in high-speed electronic demonstrations that can be viewed at close quarters. Helping the team present the results in a series of clear and understandable images is an R&S®RTA4004 1 GHz four-channel oscilloscope provided by Rohde & Schwarz.

The ViSR beamline enables demonstrations in the visible spectrum.



Rohde & Schwarz engineers, visiting Harwell, saw the ViSR demonstration being presented on outdated equipment and offered to loan the more modern instrument on a permanent basis.

The challenge – making the invisible visible

The synchrotron light does not contain continuous streams of photons, but is in fact pulses occurring at a frequency of 500 MHz. One of the demonstrations uses a high-speed optical diode to convert the ViSR beamline to a 500 MHz electrical signal, which is then compared with other light sources such as the continuous photon stream produced by an ordinary torch. It is a powerful visual demonstration of a mostly invisible phenomenon.

The 500 MHz signal is not difficult for today's oscilloscopes to capture but, as Diamond's Chris Bloomer explains, "The R&S®RTA4004 is extremely user friendly and easy to figure out. Its large screen is great for doing demonstrations with visitors, and modern connectivity options allow us to pull up the display on larger computer monitors or control the scope remotely."

The outcome – see for yourself

And was there anything in the dinosaur egg? Unfortunately, no T-Rex was found, but Diamond's non-destructive analysis was able to resolve individual grains of sand inside. We now know that if such a specimen exists, Diamond would be able to visualize it.

With the prospect of such an awesome find waiting to be discovered, why not go online at www.diamond.ac.uk and book onto the next open day to see for yourself how Diamond is helping scientists to carry out world-changing science.

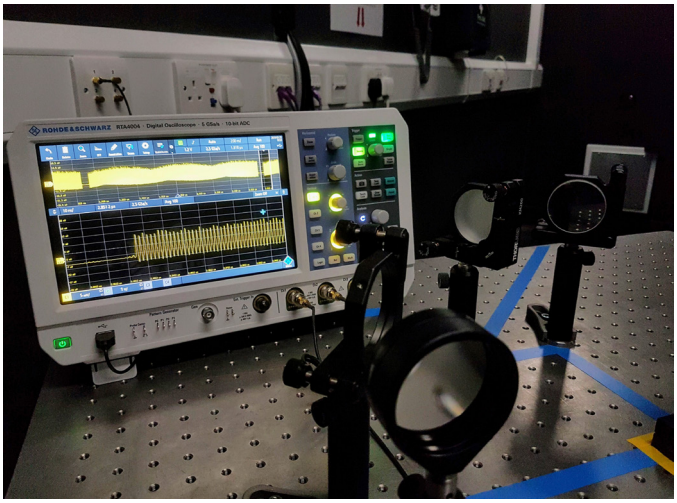
> "The R&S®RTA4004 is extremely user friendly and easy to figure out. Its large screen is great for doing demonstrations with visitors, and modern connectivity options allow us to pull up the display on larger computer monitors or control the oscilloscope remotely."
>
> **Chris Bloomer, Diamond Light Source**

The solution

Presenting large, clear pictures, aided by the R&S®RTA4004 oscilloscope, helps explain the value of Diamond to the non-scientific community. Designed with class-leading signal integrity and responsive ultra-deep memory, the R&S®RTA4004 brings the power of 10 to a new level. A Rohde & Schwarz designed 10-bit A/D converter along with class-leading noise and memory depth gives sharp waveforms, more accurate measurements and confidence when facing unexpected measurement challenges.

The R&S®RTA4004 provides users with more than just an oscilloscope. It includes a logic analyzer, protocol analyzer, spectrum analyzer, waveform and pattern generator and digital voltmeter. A large, high-resolution capacitive touchscreen with a widely acclaimed user interface makes it easy to take advantage of all these tools.

The ViSR beamline is converted to a 500 MHz signal and displayed on the R&S®RTA4004.



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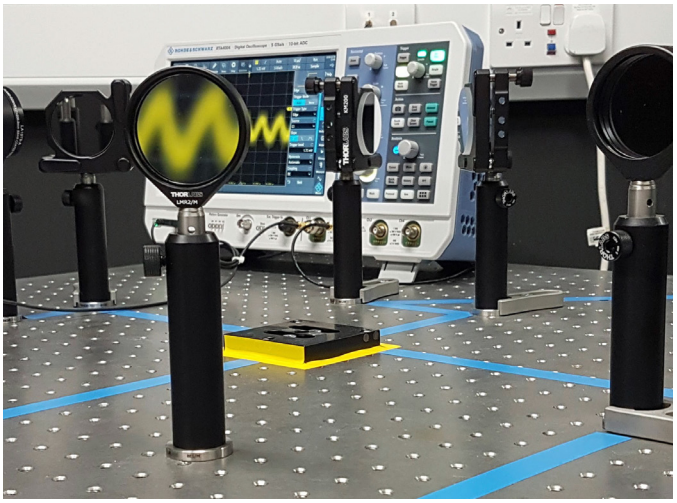

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