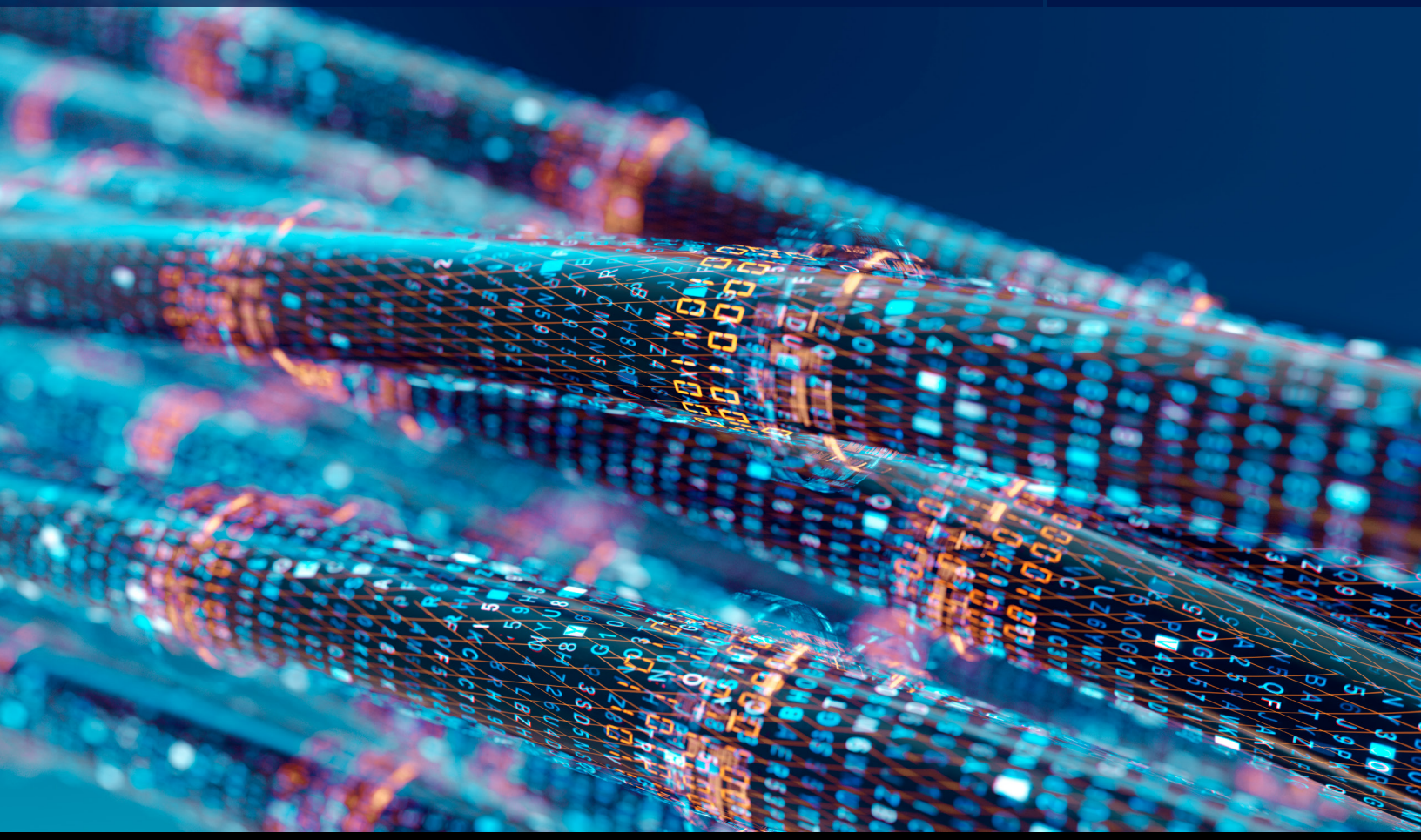
CASE STUDY



Photonic Systems Group at McGill University Overcomes Test Limitations in Optoelectronic Research

KEYSIGHT

Organization

- Photonic Systems Group at McGill University's Faculty of Engineering

Challenges

- increase capacity of optoelectronic devices
- design more bandwidth-efficient modulation schemes

Solutions

- 110 GHz UXR1104A oscilloscope
- M8199A AWG

Results

- previously unreachable levels of eye diagram analysis
- error minimization for optical fiber transmission systems
- more accurate data

Introduction

The academics who train future engineers are often the same minds behind scientific advancements catalyzing industry innovation. As professors, they prefer teaching students using current technology to provide the optimal environment for workforce development. As researchers, they need the most advanced technology to establish industry partnerships and apply for federal grant funding in a fiercely competitive landscape.

Dr. David V. Plant is Canada Research Chair and head of the Photonic Systems Group at McGill University. When he set out to advance optical fiber communications systems research for his industry collaborations, he knew he needed to eliminate test limitations and enable faster, more reliable results. Plant and his team identified the preferred technologies and tools that could handle their rigorous test requirements. They worked with Keysight to establish an innovative solution that would enable their intended results.

> If you do not know how to ask the right question, you discover nothing.
>
> — W. Edwards Deming

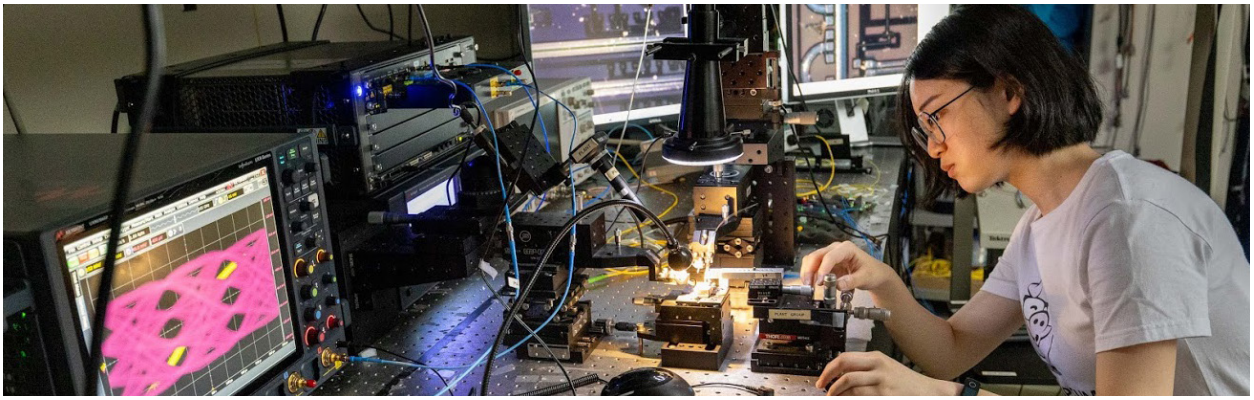
Challenges: “It’s All About the Bandwidth”

Optoelectronics is the study and application of light-emitting or light-detecting devices. It is closely related to photonics, the physical study of light. Optoelectronic devices have a broad range of applications, including display technology, autonomous vehicles, and aerospace and defense. Researchers in this field develop breakthroughs that lead to improved product performance, reduced signal interference, and more efficient energy utilization.

In this specialized industry, researchers rely heavily on traditional electronic test equipment like oscilloscopes and arbitrary waveform generators (AWGs). For example, when developing long-haul optical fiber transmission systems and short-haul data center interconnects, they use test tools with high bandwidth and sampling rates and low noise floors to achieve maximum performance.

Dr. Plant wanted to improve the acquisition and analysis capability in his lab. “Instead of building up capacity through more parallel wavelengths and fiber counts, perhaps we can increase our capacities by introducing very capable digital-to-analog (D-to-A) and analog-to-digital (A-to-D) hardware alongside signal processing techniques,” he theorized. “Every time I talk to students in the lab about what their limitations are, it’s all about the bandwidth. The right test and measurement equipment is what we look to secure, and the signal processing schemes and the enabling silicon photonic device technologies are what we develop.”

> We want to be recognized as a top group in optical fiber communications systems research. Having access to high-end test and measurement infrastructure allows us to recruit better, win more grant funding, and continue extending our reach to industry partners.
>
> — Dr. Plant

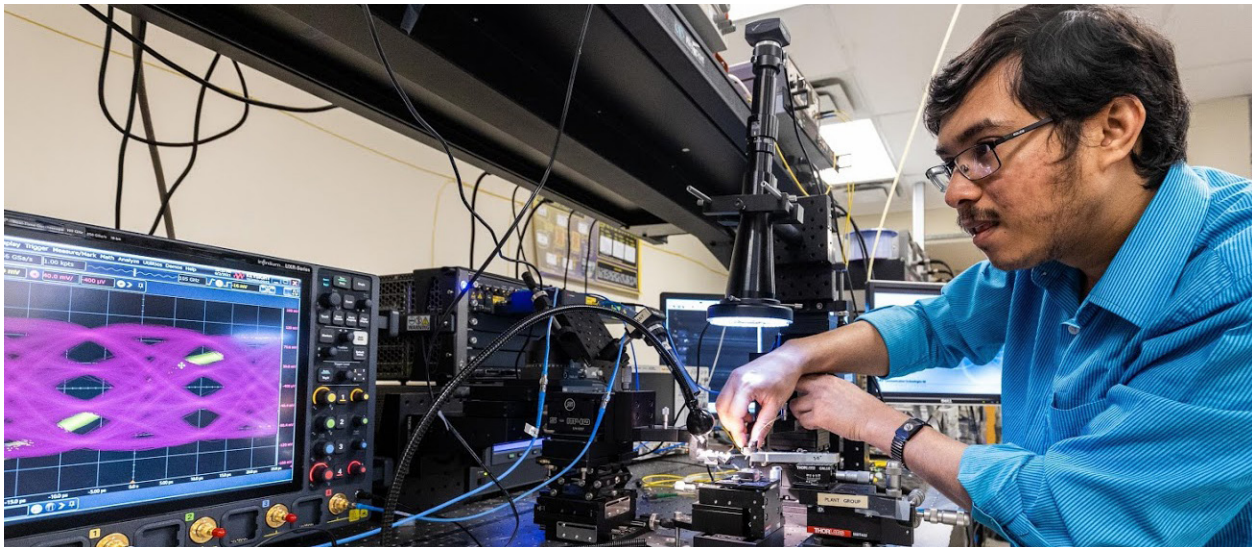


Solution: 110 GHz UXR1104A Oscilloscope + M8199A AWG

Photonic Systems Group researchers already had oscilloscopes, including midrange digital storage oscilloscopes, in their labs. For optical fiber communications systems projects, Dr. Plant's team narrowed in on three key specifications for a new equipment purchase: high bandwidth, better sensitivity, and a low noise floor. Their goal was to reach greater than 100 Gbaud for all the electronic componentry in the system to achieve maximum communication throughput.

Ultimately, Dr. Plant selected the Keysight 110 GHz UXR1104A oscilloscope paired with a Keysight M8199A AWG. These instruments are the top-performing models available in the industry. The UXR provides 110 GHz bandwidth on all four channels with less than 1 mVrms of vertical noise. The M8199A delivers 256 GS/s sample rates and up to 70 GHz bandwidth.

> The center of gravity of our research is developing new ways to increase capacity and reach using high-end D-to-A and A-to-D conversion techniques. Before we got the UXR, we had the DSOs, which ran at 63 GHz. We have two of those, which have 33 GHz over four channels — and then two channels at 63 GHz. The new Keysight solutions allow us to utilize 200 Gbaud Nyquist pulses to reach speeds up to 800 Gb, 1.6 Tb, and beyond.
>
> — Dr. Plant



Results: Greater Accuracy Opens the Door to Grants and Collaborations

McGill Photonics Systems researchers cited the UXR-Series as providing previously unreachable levels of eye-diagram analysis and error minimization when testing silicon photonic modulators.

"The sampling rate is great. The noise floor is great," Dr. Plant said. "One of my students reported that he redid a set of experiments that we did with our 63 GHz scope. He redid them with the UXR and immediately saw a 5% to 10% improvement from nothing else but because of the noise performance. When operating at higher PAM levels, the better the noise floor, the crisper those levels are at which you can make a decision." With improved test results, the team can report more accurate data for publications, which can lead to additional grants and collaborations as well as enhanced recruitment.

When submitting grant proposals to agencies like the Canada Foundation for Innovation and the National Science and Engineering Council of Canada, a primary criterion is extending the benefits of research beyond the lab to the nation and society as a whole. "The work that we do can be motivated very readily," Dr. Plant said. "It's about connectivity. It's about a better, faster, more accessible Internet. In order to reach our objectives, we seek to innovate at both the device and the systems levels."

Dr. Plant is asking the right questions, and Keysight is helping him find the answers.

The UXR represents the state of the art in ultra-high-performance real-time oscilloscopes. It offers the following features:

- up to four channels with 110 GHz of true analog bandwidth
- world's first high-performance oscilloscope series with a full high-definition 10-bit analog-to-digital converter
- low-noise analog front ends for precision signal acquisition
- only 860 µV (rms) noise at 110 GHz
- the industry's highest ENOB 5.0 bits at 110 GHz over 1 mm inputs
- down to 4 mV/div vertical scaling supported in hardware
- hardware bandwidth limit filters enable accurate scalability; correction filters ensure flat frequency magnitude and phase response
- 20 fs (typical) of intrinsic jitter produce excellent jitter characterizations

Resources

Find out more about the Keysight UXR-Series.

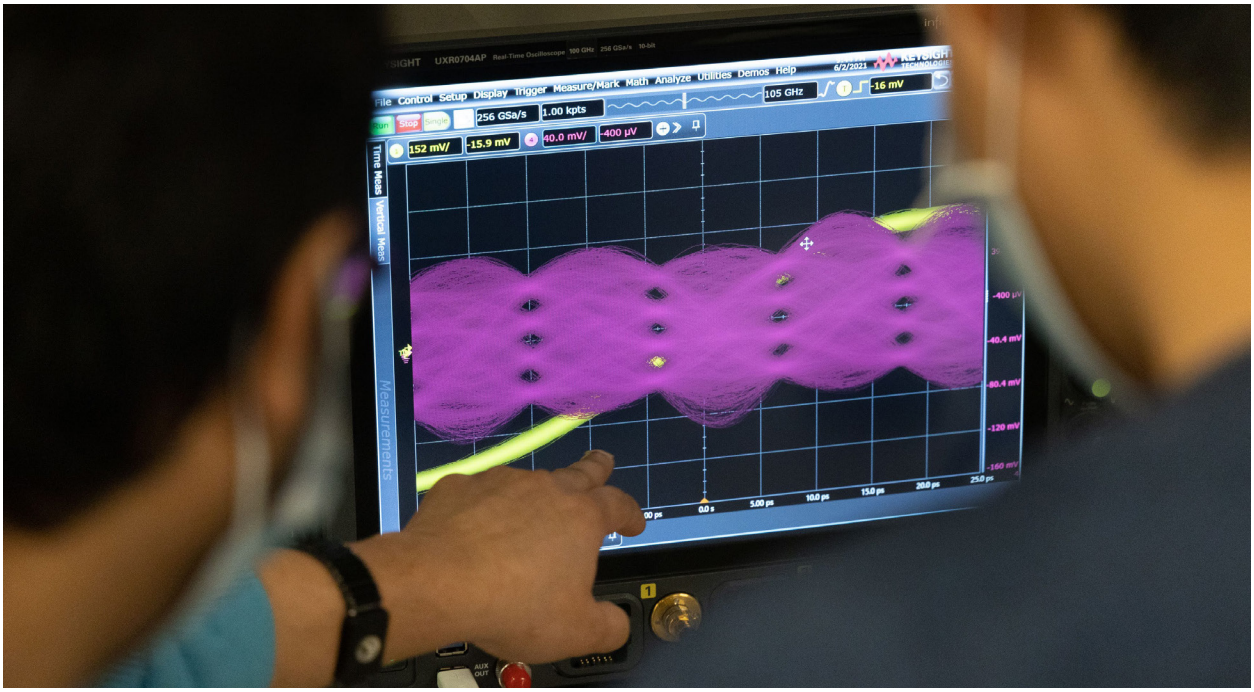


Image courtesy of Dr. Plant

Learn more about the Photonics Systems Group at McGill University.

For more information on Keysight Technologies' products, applications, or services, please visit: www.keysight.com

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