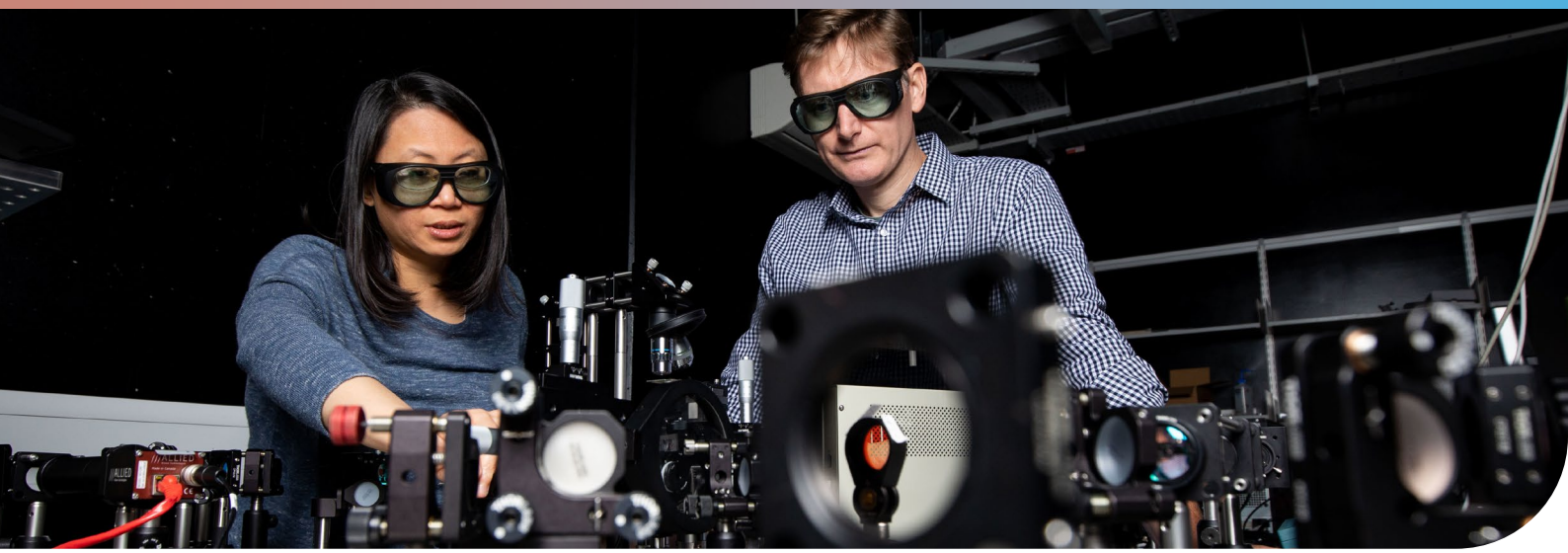
Ultra-Fast Chemical Analysis With Raman

UPDATE

First Edition | Summer 2025 | M18



Dear Reader,

Welcome to the very first edition of the uCAIR newsletter – we are delighted to have you with us!

This summer marks an exciting milestone for our project: after 18 months of dedicated collaboration across Europe, uCAIR Platform 1 is taking shape at the Bernal Institute, University of Limerick. Two important modules such as the optical alignment box and the flow cell with integrated probes have already arrived, with more to follow in the coming weeks.

With this stakeholder mailing, we are pleased to keep you informed about our progress, milestones, and upcoming developments. Thank you for your interest in uCAIR – we are glad you are reading!

If you would like to get in touch, feel free to contact us anytime at uCAIR@ul.ie – we would love to hear from you.

Sincerely,
Dr Christophe Silien
Co-ordinator uCAIR, University of Limerick

Two Important Modules Arrive at the University of Limerick for uCAIR 1 Platform Integration

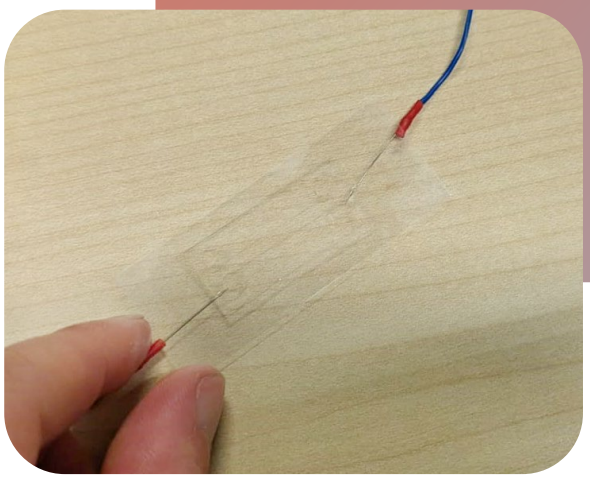
After months of coordination, design, and refinement two critical components for the setup of the uCAIR 1 platform have arrived at the Bernal Institute at the University of Limerick, Ireland.

The optical alignment box, provided by LLS Rowiak (Hannover, Germany), is designed to ensure precise laser beam alignment – enabling optimal focus on the sample and maximizing signal quality. This component plays a vital role in maintaining both measurement accuracy and system stability within the uCAIR 1 platform. The alignment box is now on-site and ready for integration with additional components from LambdaX and Multitel.

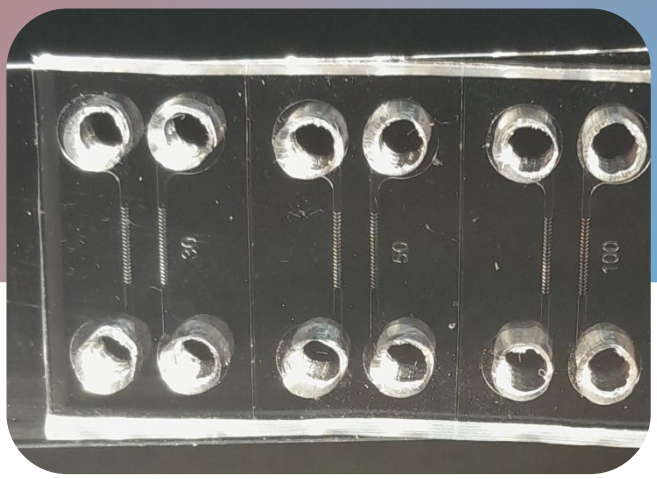
In parallel, flow cells for microfluidic experiments have been delivered by the Institute of Scientific Instruments of the Czech Academy of Sciences. This unit will enable real-time, inline analysis of biomarkers in fluids, supporting uCAIR's mission to develop automated, modular systems for advanced reaction monitoring.

Meanwhile, preparations are underway in the laboratory for the integration and calibration of these components as the uCAIR 1 system continues to take shape.

It is immensely rewarding to see the parts of the platform coming together. As assembly continues, we are entering a dynamic phase of the project – one that brings tangible progress and growing anticipation for what is ahead.



Making the right connections – first setup of the flow cell for real-time monitoring in uCAIR 1.
© University of Limerick



Microfluidic test structures with channel widths from 25 to 100 µm – enabling precise flow control for inline process monitoring.
© Institute of Scientific Instruments of the Czech Academy of Sciences

Progress in Beam Control: LLS Rowiak Delivers High-Performance Alignment Module for uCAIR 1

Laser Interface Box by LLS Rowiak.
© LLS Rowiak GmbH

Laser Interface Box by Setup of Laser interface box in LLS Rowiak Lab.
© LLS Rowiak GmbH

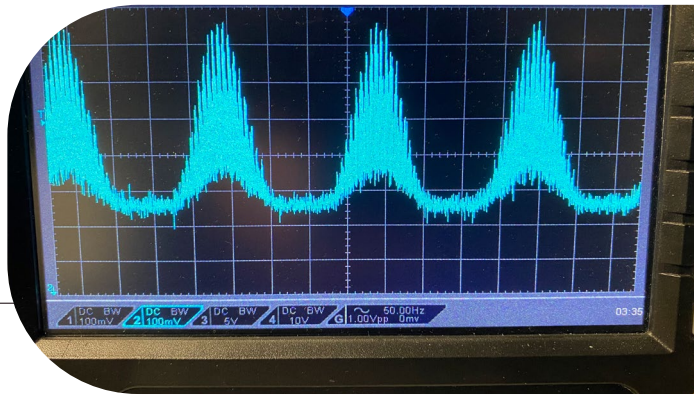
At the beginning of April, German industrial partner LLS Rowiak, completed the development and setup of the beam alignment and control module – an essential component for synchronized, multi-wavelength Raman measurements. This sophisticated optical module combines four laser beams of different wavelengths into a single output, enabling precise spatial and temporal alignment of picosecond laser pulses.

The module surpassed expectations. While the target transmission was set at over 50 %, LLS Rowiak achieved an impressive 60 % transmission of the total laser input power at the module's exit. This marks a significant technical achievement for the platform, enhancing the efficiency and performance of the overall system.

The module has since been delivered to the University of Limerick, where it will be installed, aligned, and tested in laboratories of the university once the laser module from Belgian partner Multitel arrives.

This milestone brings the uCAIR 1 platform another step closer to its goal of automated, modular, and high-resolution real-time single cell spectroscopy.

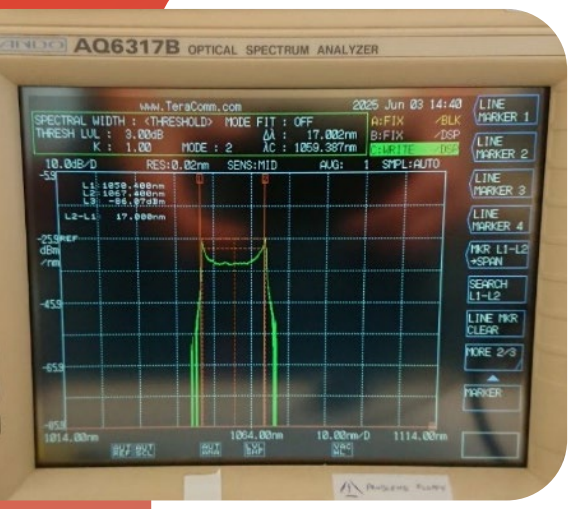
Laser control: checked, tested, and AOM-approved!
© LLS Rowiak GmbH



Off we go... The laser interface box is ready for travel.
© LLS Rowiak GmbH

At the Lab with Multitel

As part of the uCAIR consortium, Multitel is responsible for the development of an innovative light source. To this end, a series of tests have been conducted to achieve emission within the relevant wavelength range. Conventional light sources are typically not optimized for coherent anti-Stokes Raman scattering (CARS). However, by employing second harmonic generation (SHG) and appropriate wavelength separation, it is possible to tailor the spectral output to meet the specific requirements of CARS applications, as defined by the objectives of the uCAIR project.



The "Batman Spectrum". © Multitel

The "Batman Spectrum"

The optical spectrum analyzer (OSA) displays the spectral content of the tunable picosecond pulsed source. Since the central wavelength rapidly oscillates at 70 kHz, the device integrates the emitted spectra into a composite picture spanning roughly 1050 nm to 1068 nm.

This fast scanning is achieved using a Fabry-Pérot filter placed immediately after coherent supercontinuum generation in a nonlinear fiber. The spectral linewidth of our picosecond pulses is approximately 300 pm.

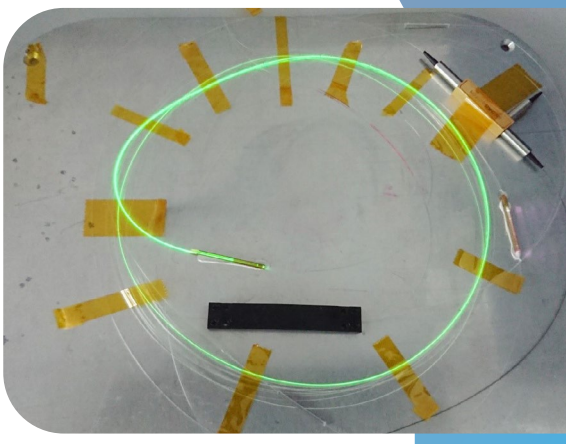
Combined with another synchronous picosecond pulse train at wavelength of 800 nm, this setup is ideally suited for high-resolution, fast-scan CARS/SRS experiments.

"Green for red"

The high-power erbium-doped fiber amplifier operates at a long wavelength of 1600 nm. It delivers picosecond pulses with peak powers in the kilowatt range and an average output power of 1 watt.

These amplified pulses are subsequently frequency-doubled to generate red light at 800 nm via second harmonic generation (SHG).

The visible green light seen in the image originates from up-conversion luminescence within the erbium-doped fiber and represents only a minor fraction of the amplifier's output power.



"Green or red". © Multitel

Selected Recent uCAIR Contributions

Charlie O'Mahony and David O'Brien, UL: Illumination and Spectral Sparsity for Super-Resolution Coherent Anti-Stokes Raman Scattering (CARS), Focus on Microscopy 2025 (FOM2025) in Taipei City, **Taiwan https://www.focusonmicroscopy.org/2025-program-online/?event_id=8024**

Maxime Zerbib, Simon Colombel, Kien Phan Huy, Jean-Charles Beugnot: On-demand tapered optical fiber, paper 13522-74, WSOF, April 2025, SPIE WSOF, Prague, **https://spie.org/workshop-on-specialty-optical-fibers-and-their-applications/presentation/On-demand-tapered-optical-fiber/13522-74**

Simon Colombel, Maxime Zerbib, Raphael Amerette, Jérôme Salvi, Jean-Charles Beugnot: Thermal effects on the Brillouin frequency shift in strained optical silica nanofibers, paper 13522-67, WSOF, April 2025, SPIE WSOF, Prague, **https://spie.org/workshop-on-specialty-optical-fibers-and-their-applications/presentation/Thermal-effects-on-the-Brillouin-frequency-shift-in-strained-optical/13522-67**

Maxime Zerbib, Simon Colombel, Kien Phan Huy, Jean-Charles Beugnot: 10 dB Brillouin gain in a silica nanofibers, paper 13522-22, WSOF, April 2025. SPIE WSOF, Prague, **https://spie.org/workshop-on-specialty-optical-fibers-and-their-applications/presentation/10-dB-Brillouin-gain-in-a-silica-nanofibers/13522-22**

Fabian Ott, Tobias Meyer-Zedler, Michael Schmitt, Jürgen Popp: Image-based fuzzy logic control for pressure-driven droplet microfluidics as autosampler for multimodal imaging microscopy Royal Society of Chemistry (RSC): Lab on a Chip, **https://doi.org/10.1039/D4LC00583J; https://pubs.rsc.org/en/content/articlelanding/2025/lc/d4lc00583j**

Edoardo Farnesi, Matteo Calvarese, Chen Liu, Carl Messerschmidt, Mohammad Sadegh Vafaeinezhad, Tobias Meyer-Zedler, Dana Cialla-May, Christoph Krafft, Jonas Ballmaier, Orlando Guntinas-Lichius, Michael Schmitt and Jürgen Popp: Advancing cerumen analysis: exploring innovative vibrational spectroscopy techniques with respect to their potential as new point-of-care diagnostic tools, Analyst, DOI: 10.1039/D4AN00868E

Meet us!

You can find uCAIR partners during this upcoming event:

Project members from Multitel will present a paper „1605nm picosecond fiber laser" during Optica Laser Congress and Exhibition in **Prague on 19 – 23 October, 2025**.

www.optica.org/events/congress/laser_congress/

Optica Laser Congress and Exhibition

uCAIR Mission

With uCAIR, we strive to develop a novel laser technology combined with AI-enhanced signal processing, creating a pioneering Raman-based diagnostic system suitable for endoscopic procedures in oncology and beyond. By detecting molecular-level disruptions in the life cycle of biological cells, our real-time and non-invasive imaging solution holds the potential to significantly improve healthcare.

Facts

Duration: January 01, 2024 – June 30, 2027 | 42 months
Funding: EUR 5 Mio.
Coordinator: University of Limerick | Consortium of 11 partners from 6 countries | 5 SMEs

Follow us on LinkedIn – uairproject!

Subscribe today for the uCAIR Stakeholder Mailing List!

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Newsletter edited by VDI/VDE Information + Technik GmbH on behalf of the uCAIR Consortium
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