Ultra-Fast Chemical Analysis With Raman

UPDATE

Second Edition | Summer 2026 | M30

Image: VDI/VDE Innovation + Technik GmbH

Key milestone reached: First Demo Day

Right at the beginning of this year, on January 29, the uCAIR consortium successfully hosted its first showcase event **uCAIR Exploring Photonics: Lasers, Microscopy and Characterisation** at Bernal Institute, University of Limerick, Ireland.

The event brought together around 30 participants, primarily from the fields of medical research, photonics, and related scientific domains, alongside representatives from technology transfer. The agenda featured a combination of industry and research presentations, technical sessions on Raman spectroscopy and microspectroscopy and live lab demonstrations and poster sessions.

However, what truly stood out was the hands-on experience in the lab. Seeing the uCAIR setup firsthand sparked lively discussions, deep engagement, and valuable exchange among participants. This direct interaction with the technology proved to be a key highlight, going far beyond traditional presentation formats.

The Demo Day marked an important achievement: Platform 1 has been successfully assembled and demonstrated. The event clearly showcased the potential of combining photonics and AI for next-generation, non-invasive diagnostics. Supported by valuable discussions and postive feedback from the community, uCAIR continues its path towards advancing real-time, non-invasive cancer diagnostics.

We are now looking forward to the development and preparation of uCAIR2 - and its demonstration to the audiences in 2027!

Watch the video on LinkedIn!

Image: VDI/VDE Innovation + Technik GmbH

LLS Rowiak grants a glimpse at the optomechanics and the interface of platform uCAIR2

Following the successful showcase of uCAIR1 in January, the consortium is now advancing towards the next major milestone, uCAIR2. While uCAIR1 demonstrated the feasibility of our breakthrough technology, uCAIR2 is designed to take the next step towards clinical usability.

uCAIR2 will feature

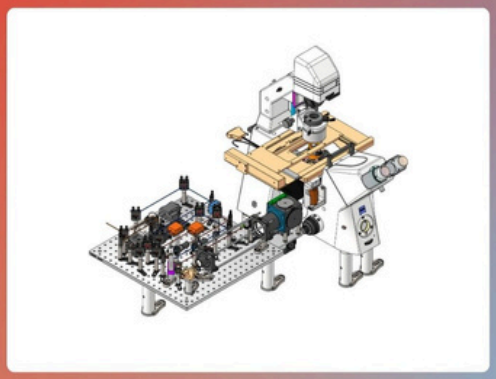
- Faster scanning rates
- More user-friendly because of the high level of integration
- Enhanced system performance

Designed with future clinical workflows in mind, the new interface aims to simplify access to highly complex Raman imaging and AI-supported analysis, bringing molecular-level diagnostics one step closer to real-world healthcare applications.

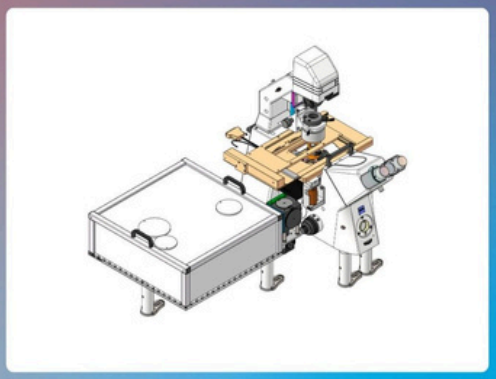
As development of uCAIR2 progresses, our partners are integrating highly sophisticated optomechanical components into the next-generation prototype.

The following images provide a glimpse into the technological heart of the system currently under construction at the lab of uCAIR partner LLS Rowiak LaserLab Solutions GmbH. They show carefully engineered optical pathways for precision optics and compact system integration.

A side view of the 3D assembly



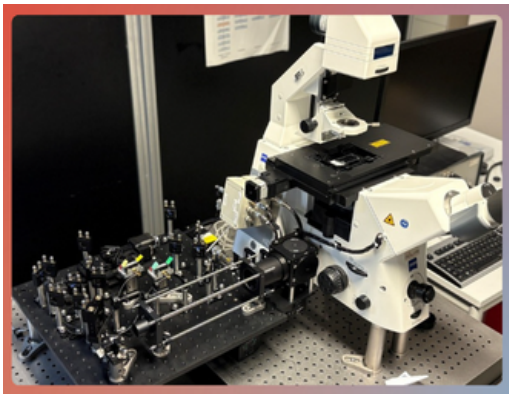
The optomechanical components are used for positioning the optics.



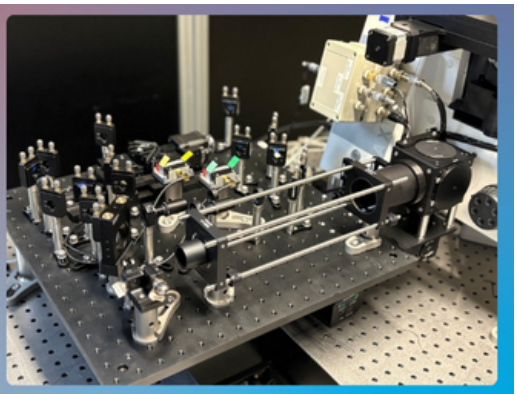
A side view of the 3D assembly with the housing

Images: LLS Rowiak LaserLabSolutions GmbH

The current setup



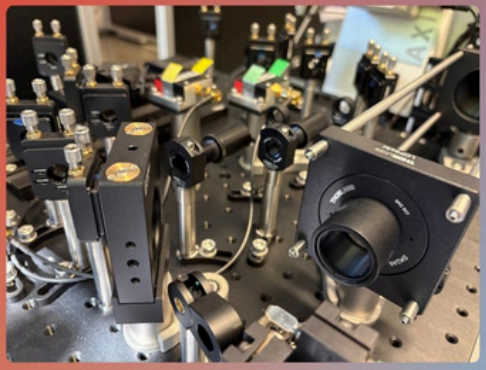
The platform uCAIR2 in the lab



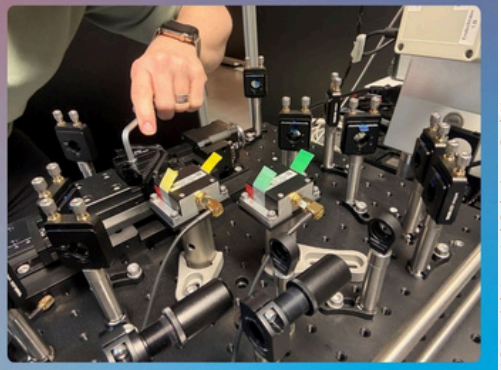
The optomechanical components and their integration into the microscope

Images: LLS Rowiak LaserLabSolutions GmbH

The optomechanical components



Detailed view of optomechanical components



Work in progress: Optimizing the positioning of the various components

Images: LLS Rowiak LaserLabSolutions GmbH

Open Science from within uCAIR: paper and related data available

A significant paper has been published in Springer Nature's *Discover Imaging* journal:

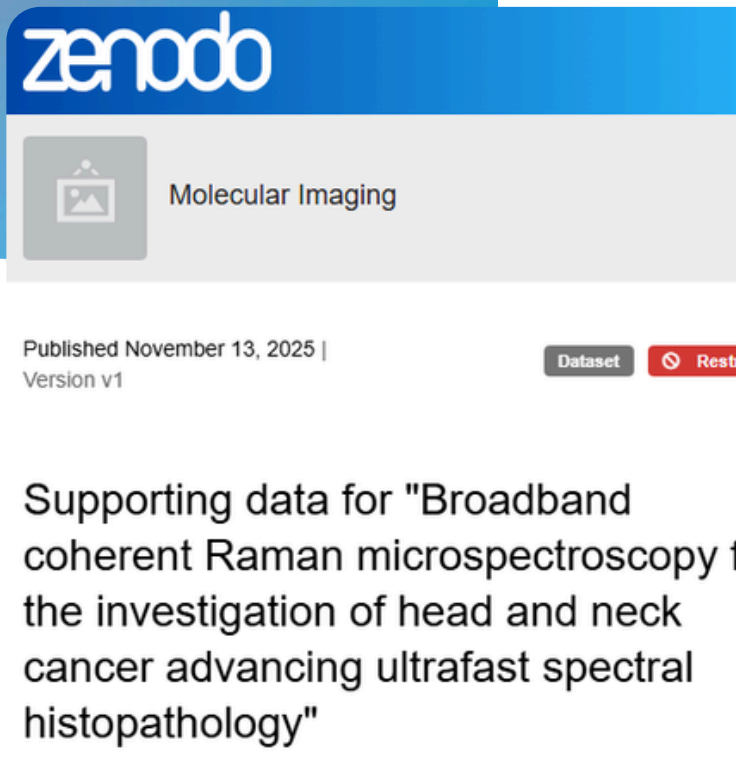
Broadband coherent Raman microspectroscopy for the investigation of head and neck cancer advancing ultrafast spectral histopathology by Carl Messerschmidt, Matteo Calvarese, Mohammad Sadegh Vafaeinezhad, Oleg Ryabchykov, Anna Mühlig, Tobias Meyer-Zedler, Michael Schmitt, Orlando Guntinas-Lichius, Thomas Bocklitz and Juergen Popp.

Coherent Raman Scattering (CRS) imaging is moving from nice-to-have to need-to-have in cancer diagnostics and this publication shows why. The key highlights are:

- Strong discrimination capability across patient tissue samples
- First proof-of-concept AI-based classification model
- High-speed imaging with a 134 µs dwell time – an order of magnitude faster than comparable multiplex CARS setups
- A major step towards ultrafast spectral histopathology and real-time diagnostics

The full open-access article is avilable here.

Along with the paper, uCAIR partners made the supporting data publicly avaible upon request. All supporting data are available on Zenodo here.

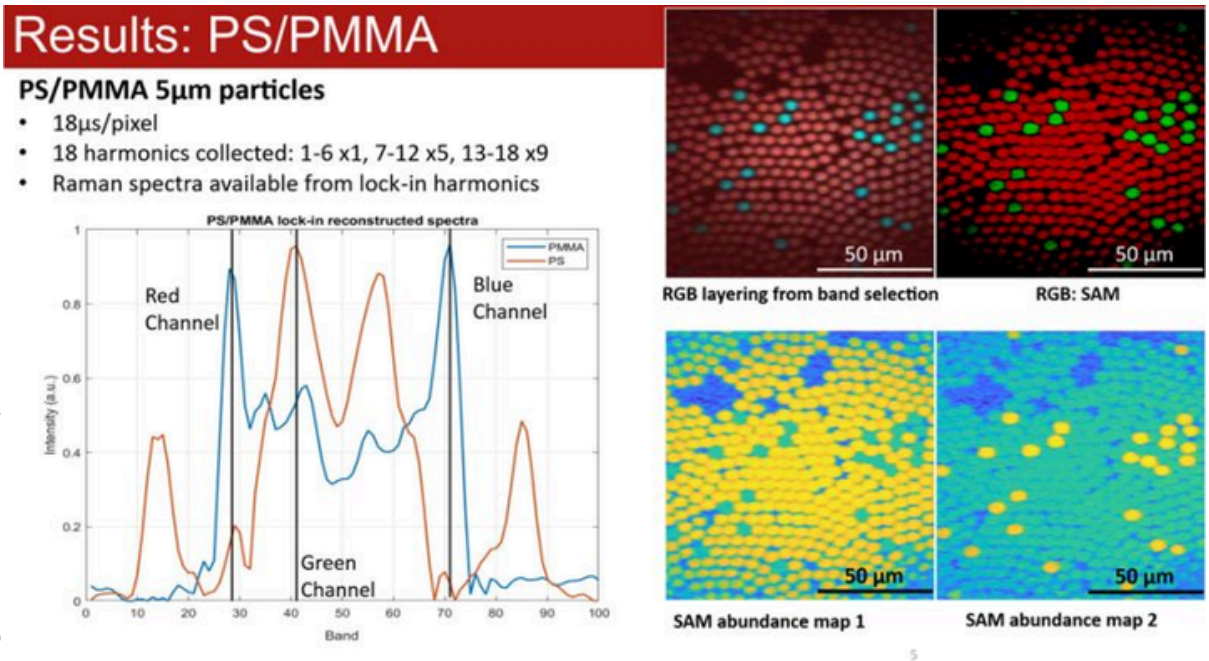


New results from the uCAIR1 microscope: high-speed chemical imaging in action

In November 2025, uCAIR shared new experimental results from the uCAIR platform 1 microscope. Partners had successfully demonstrated chemically selective imaging of the polymers Polystyrene and PMMA, achieving clear contrast between the two chemical species.

The key achievement: imaging performed at just 18 µs dwell time per pixel — an important step toward high-speed, label-free chemical imaging.

By enabling rapid and precise identification of chemical compounds, these results marked a milestone for the uCAIR project and brought partners closer to delivering advanced diagnostic capabilities based on coherent Raman imaging.



Images: Bernal Institute, University of Limerick

uCAIR explained by the experts: Watch our video series on LinkedIn!

How uCAIR outperforms existing systems

Four laser beams in one system

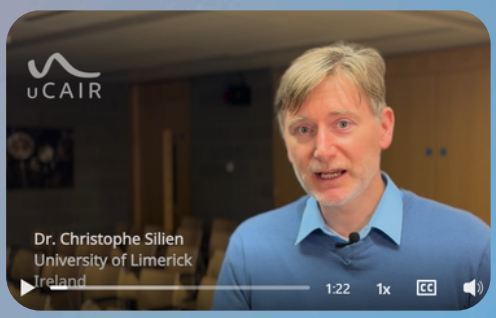
A very special fibre

The right electronics

Evaluation and benchmarks

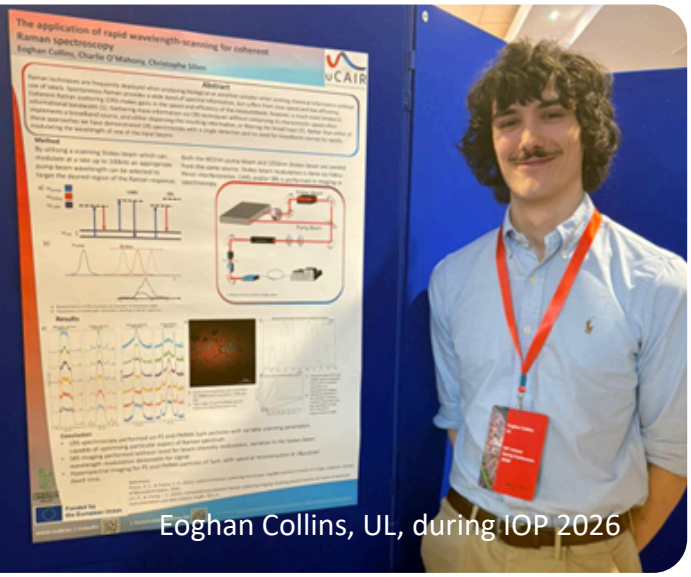
Impact on non-invasive diagnostics

Exploitable results



We thank all uCAIR partners for their valuable contribution!

Selected recent uCAIR Activities and Contributions


Eoghan Collins, UL, during IOP 2026

Eoghan Collins, Charlie O'Mahony, Muqian Wen, Christophe Silien, with acknowledgements to Multitel, LLS, LX: *The application of rapid wavelength-scanning for coherent Raman spectroscopy,* Institute of Physics (IOP), Ireland Spring Conference

Aishwarya Venkataramanan, Sai Karthikeya Vemuri, Adithya Ashok Chalain Valapil, Joachim Denzler: *Uncertainty-aware Physics-informed Neural Networks for Robust CARS-to-Raman Signal Reconstruction*, EurIPS 2025 https://arxiv.org/html/2511.13185v1

Gil Fanjoux, Maxime Zerbib, Simon Colombel, Romain Morel, Kien Phan-Huy, Thibaut Sylvestre, Jean-Charles Beugnot: *Broad tunability of intramodal four-wave mixing in optical microfibers via diameter variation*, OPTIQUE BFC 2026

Eoghan Collins, Peuli Ghosh, Charlie O'Mahony, Muqian Wen, Sarah Hudson, Christophe Silien, with acknowledgements to Multitel, LLS, LX: *uCAIR: An ultrafast solution for coherent Raman imaging based chemical fingerprinting for drug characterisation*, SSPC Industry and Academic Symposium 2026

Eoghan Collins, Charlie O'Mahony, Muqian Wen, Aengus McGill, Jean Bernard Lecourt, Yves Hernandez, Syed A.M. Tofail, Ning Liu, Christophe Silien, with acknowledgements to Multitel, LLS, LX: *Ultrafast coherent Raman with time/spectral compression,* SPIE 2026 Photonics Europe

Adithya Ashok Chalain Valapil, Carl Messerschmidt, Maha Shadaydeh, Michael Schmitt, Jürgen Popp & Joachim Denzler: *Deep Learning-Assisted Dynamic Mode Decomposition for Non-resonant Background Removal in CARS Spectroscopy,* DAGM GCPR 2025 https://doi.org/10.1007/978-3-032-12840-9_4

T. Meyer-Zedler, M. Calvarese, H. Bae, A. Mühlig, M. Schmitt, C. Lai, K. Reichwald, B. Messerschmidt, T. Eidam, O. Guntinas-Lichius, T. Bocklitz, M. Schmitt, J. Popp: *Combining Multimodal Nonlinear Endoscopy,* EUROPT(R)ODE XVII

C. O'Mahony, E. Collins, Z. Pilát, O. Samek, C. Messerschmidt, T. Meyer-Zedler, M. Schmitt, N. Liu, C. Silien: *Leveraging λ-scanning fibre laser to achieve high speed, Hyper-spectral Coherent Raman imaging,* FOM 2026

Jean-Bernard Lecourt: *1605nm picosecond fiber laser* Optica Laser Congress and Exhibition


Jean-Bernard Lecourt, Multitel, during Optica Laser Congress 2025

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 – December 31, 2027 | 48 months
Funding: EUR 5 Mio.
Coordinator: University of Limerick | Consortium of 11 partners from 6 countries | 5 SMEs

uCAIR Partners

Contact

Coordinator
University of Limerick
Dr. Christophe Silien
ucair@ul.ie

Follow us on LinkedIn!

Stakeholder Mailing List

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