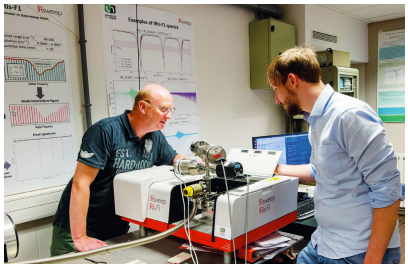

© UNamur - O. Browet, specialised technician, and J. Clement, assistant in the physics department and PhD student at LLS

IRis-F1, designed by the Swiss company IRsweep AG, is the next generation of fast, broadband, high-resolution dual comb spectrometers. Here’s a look back at a technological breakthrough and a predicted success.

In 2005, the Nobel Prize in Physics was awarded for contributions to the quantum theory of optical coherence and the development of laser-based precision spectroscopy, including the optical frequency comb technique. Some years later, Prof. Dr Jérôme Faist at ETH-Zurich led a PhD thesis on developing a dual comb spectrometer based on quantum cascade lasers. This was the first of its kind operating in the mid-infrared, one of the most interesting areas of the electromagnetic spectrum for studying the atmosphere and many other applications, but also very challenging from the technological point of view.

Ultimately, the PhD thesis of Dr Andreas Hugi led to the development of a marketable instrument and the creation of a spin-off in 2014: IRsweep. In its first version, the IRis-F1 spectrometer takes measurements with a time resolution of less than a microsecond. Its luminosity enables its use in a wide range of applications, even in very dense environments, and it works over a broad spectral range. Applications of IRis-F1 are already numerous, including studying protein dynamics, diagnosing combustion, performing polymer chemistry analyses, monitoring dental curing, and analyzing liquids and solids across physics, chemistry, biology, pharmaceuticals, and biotechnologies.

In 2019, Prof. Dr Muriel Lepère, director of the LLS at UNamur, discovered IRis-F1 and challenged IRsweep to develop a new version with high spectral resolution, perfect knowledge of the relative wavelength scale, and an excellent signal-to-noise ratio. A technological and scientific collaboration between IRsweep and Namur’s team began with the acquisition of IRis-F1 by Prof. Dr Muriel Lepère in 2020. This marked the start of joint development of the instrument, combining the expertise of LLS and IRsweep.

This collaboration led to the second improved version of the spectrometer, featuring high spectral resolution for gas studies and temporal resolution capabilities for liquids

and solids. This technological breakthrough has been the subject of several scientific publications. The first, a seminal paper, appeared in *Nature* in 2014 (*Nature* 492 (7428), 229-233, by A. Hugi, G. Villares, S. Blaser, H.C. Liu, J. Faist). Another, published in 2022, focused on the characterization of the new IRis-F1 version, with Prof. Dr Muriel Lepère as the first author (*Journal of Quantitative Spectroscopy and Radiative Transfer* 287, 108239, by M. Lepère, O. Browet, J. Clément, B. Vispoel, P. Allmendinger, J. Hayden, F. Eigenmann, A. Hugi, M. Mangold).

In summer 2023, Prof. Dr Lepère was an invited speaker at Optica, the American leading society in optics and photonics, sensing congress. Other sources of pride for her include Jean Clément, the world’s first PhD student working on the new IRis-F1 version, who won first prize at the annual meeting of the Belgian Physical Society in 2023 for his study of methane. The quality of the results recently obtained with IRis-F1 allows the LLS team to present several communications at international conferences, fostering exchanges that lead to new projects and collaborations. Her team has now acquired the expertise to use and further develop the instrument.

The IRis-F1 spectrometer of LLS is unique in the Belgian market. It has already established itself as a benchmark instrument thanks to its broad spectral range and performance. Moreover, the signal quality is continuously improved by Olivier Browet, a specialized technician at LLS, while the field of application is broadened through meetings with specialists from different disciplines.

For Prof. Dr Lepère, one thing is certain: this is an instrument for the future. By combining fundamental research, applied research, and a marketing approach, Prof. Dr Muriel Lepère has transformed her outlook. Her vision now encompasses simulations, measurements, technological developments, and collaboration with industry—a continuum that promises even greater advances in science!

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Laboratory of Lasers and Spectroscopies (LLS)
UNamur
Rue de Bruxelles 61 – B-5000 Namur
Tel.: +32 (0)81 724 584 – Email: muriel.lepere@unamur.be
https://www.unamur.be/en/sciences/physics/research/lls