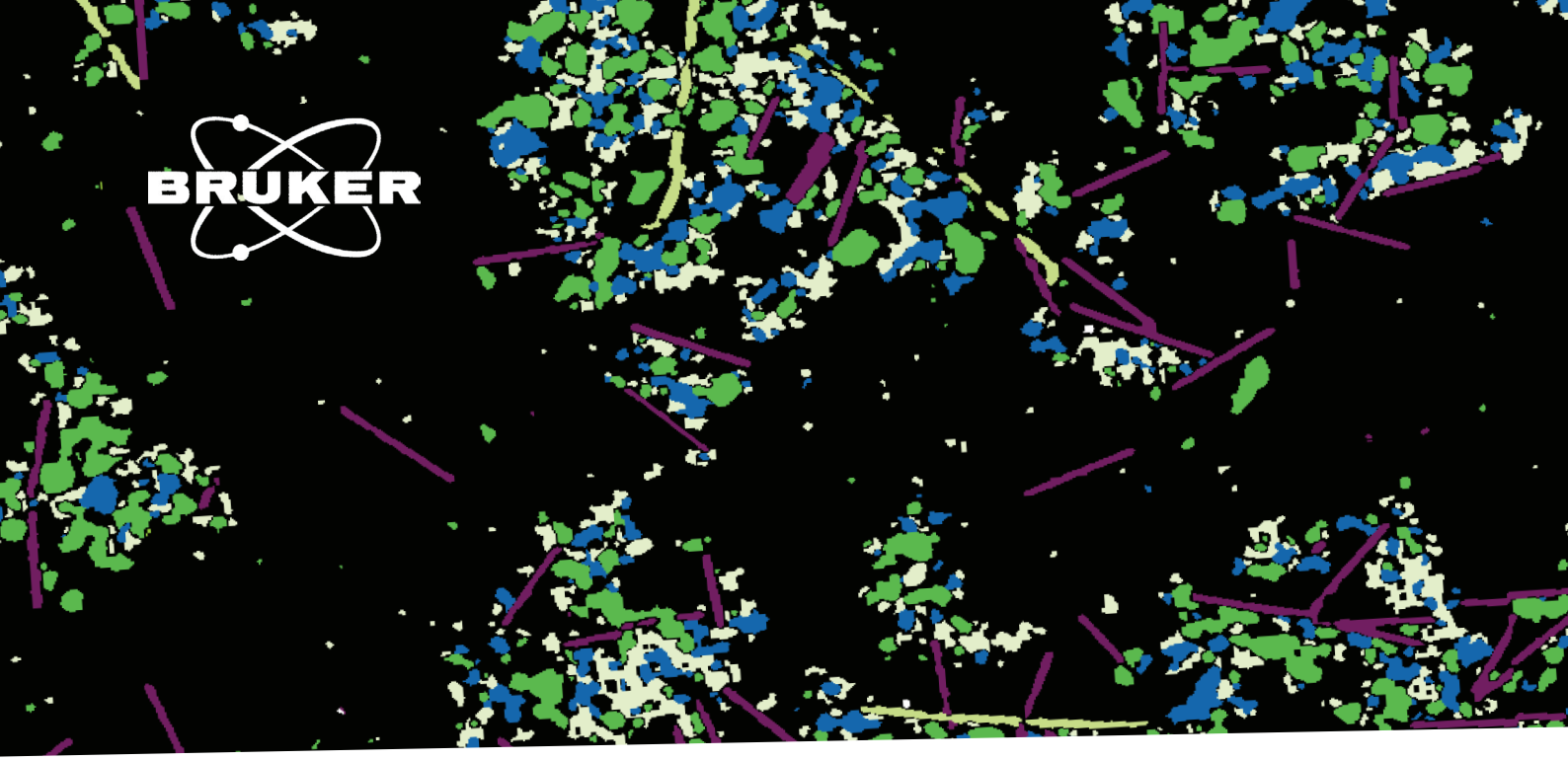


IR LASER IMAGING MICROSCOPES

The ParticlePlus™ Workflow

Breaking Bottlenecks in Microplastics Imaging

IR Laser Imaging for Microplastics Analysis

Infrared Laser Imaging (ILIM) enables rapid and highly specific microplastic detection and classification across whole filters. When paired with the ParticlePlus™ software workflow, it transforms microplastic analysis into a standardized and scalable solution with instant results. The software automates data acquisition for whole filters and integrates artificial intelligence (AI)-driven data analysis to detect and classify microplastics of any shape and size.

System, Setup, and Methodology

The ParticlePlus™ workflow is designed for IR Laser Imaging (ILIM) microscopes. For this study, we employed the following setup:

- **Sample Details**
  Microplastic particles collected on 25 mm Whatman® aluminum oxide filter (i.e., anodisc filter) with 0.2 µm pore size.

- **Measurement Setup**
  The LUMOS II ILIM in transmission mode and the software workflow ParticlePlus™ were used to perform automated whole filter imaging. The laser wavelength was tuned with a spectral step size of 4 cm^{-1} across the MIR fingerprint region of 1800 to 1250 cm^{-1}.

- **Data Analysis Tool**
  Following data acquisition, the hyperspectral data is automatically processed and analyzed by the MPID plugin, requiring no user input.

Creating Work Items

First, a work item is created by assigning the corresponding workflow configuration to the sample ID (Figure 1A). The configuration of the workflow includes the type of filter (e.g., anodisc, metal-coated or silicon filters) and spectral parameters such as acquired wavenumber range and step size. Depending on its status, work items are listed under the 'Planned' (Figure 1B) or 'Done' tab (Figure 1C) and can be loaded or accessed at any time. This allows easy scheduling and keeping track of experimental series.

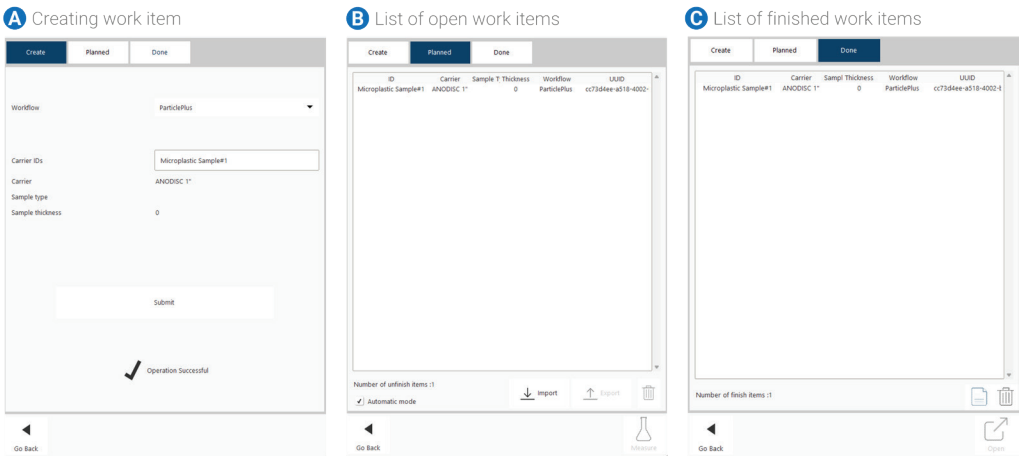


Fig. 1
Creating and organizing work items in ParticlePlus™.

Automated Data Acquisition for Whole Filters

Figure 2A shows the flexible sample plate concept supporting common filter types and sizes for microplastic analysis. The dedicated sample plate for Ø 25 mm IR-transparent filters (e.g., Anodisc and silicon filters) features three filter positions, including a designated reference position (upper right) for background acquisition.

Complementary sample plates are available for IR-reflective filters (e.g., gold- or aluminium-coated filters) enabling efficient batch analysis of up to three Ø 25 mm filters or analysis of a single Ø 47 mm filter. The system recognizes the installed sample plate and visualizes the corresponding filter layout, delivering guided and automated data acquisition (Figure 2B).

First, the background acquisition is automatically performed, followed by z-axis focus adjustments at seven predefined positions on the sample filter. These focus coordinates are then used to calculate the filter topography, ensuring constant focus and the highest-quality spectral data across the entire filter (Figure 2C).

The IR live view provides a 2.2 x 2 mm field of view (FOV) and allows inspection of filter samples at any wavenumber from 1800 to 950 cm^{-1} before starting the experiment (Figure 2C).

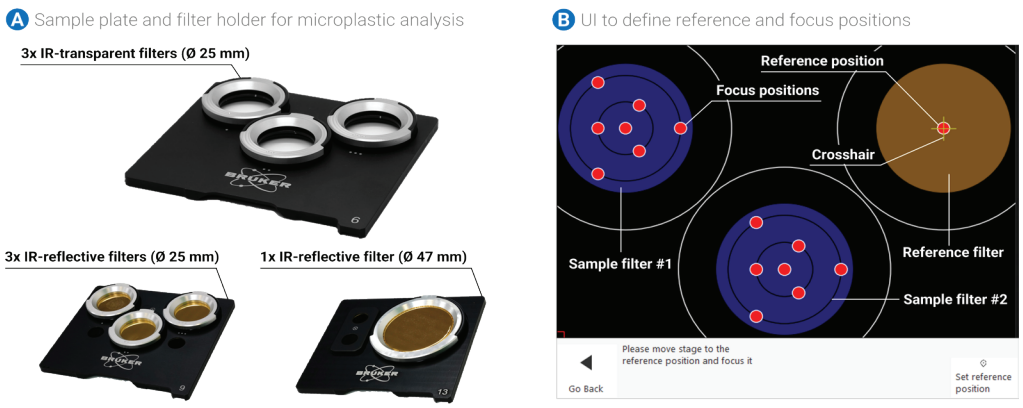


Fig. 2A, 2B
Setting up the automated whole filter experiment.

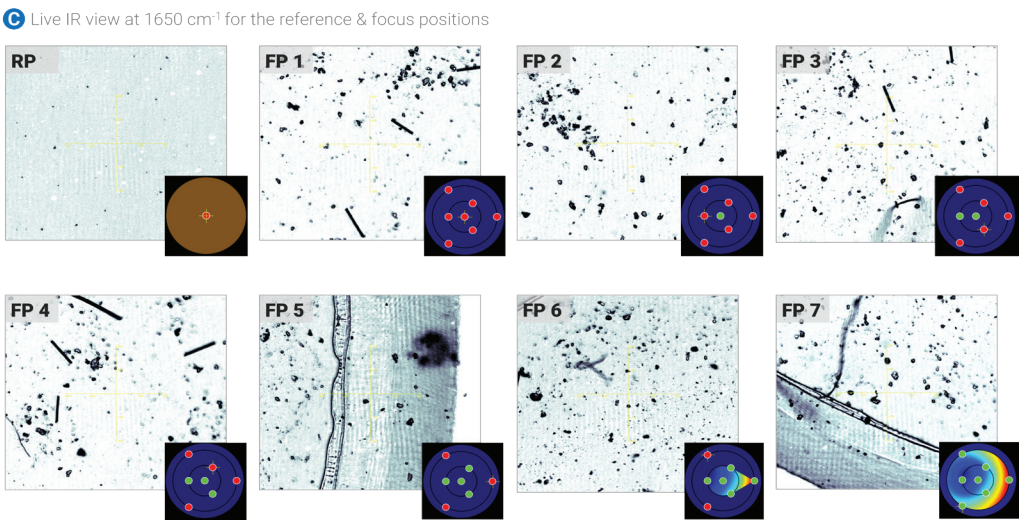


Fig. 2C
Live IR view at 1650 cm^{-1} for defined focus positions.

Next, the system automatically performs hyperspectral acquisition of the sample filters. A complete Ø 25 mm filter is analyzed in only 13 minutes, independent of the number of detected particles. During this time, 22.5 million MIR fingerprint spectra are acquired and automatically processed by the MPID data analysis plugin.

Integrated Data Analysis by MPID for Instant Results

Bruker's Microplastic Identifier (MPID) performs automated detection and identification of polymer particles using deep-learning (DL) and machine-learning (ML) models. These models were trained on dedicated ILIM data repositories derived from verified reference materials for all major polymer types.

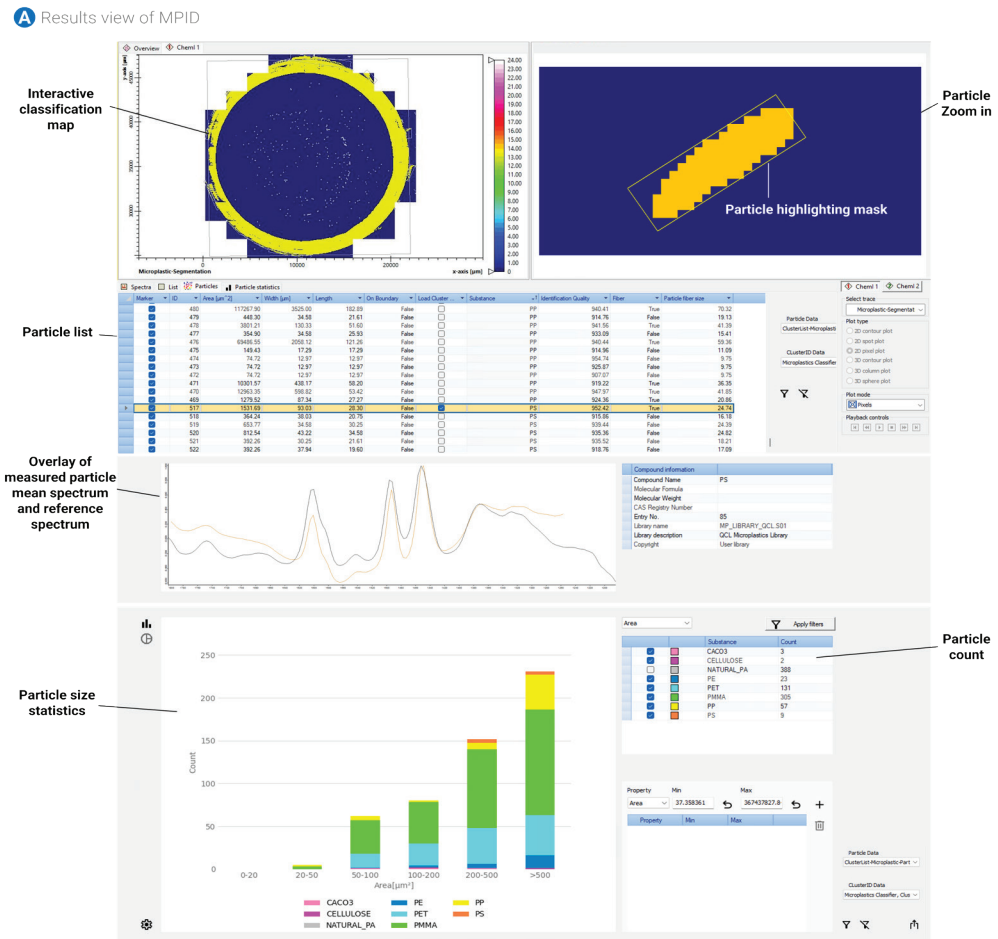


Fig. 3
Acquiring comprehensive results by MPID.

This ensures reliable, high-confidence identifications, even for degraded or mixed polymers. A comprehensive description of the MPID algorithm is provided in Product Note M210.

MPID processes a complete filter in ≤ 15 minutes and delivers a structured results view for each analysis (Figure 3A). The core element is an interactive classification map that displays the spatial distribution of identified particles across the filter. The map comes with zoom and scale measurement functionality and is directly linked to the particle list (Figure 3A).

Selecting a particle in either view highlights the corresponding entry in the other and its mean spectrum is shown overlaid with the corresponding reference spectrum from the library (Figure 3A).

The particle list reports particle ID, size, shape, assigned polymer class, and identification quality. Summary statistics for particle counts and size distributions are automatically generated and presented as bar plots and pie charts (Figure 3A).

Figure 4A displays a representative results summary for a typical microplastic sample. In this case, the total turnaround time was 17 minutes, including automated data acquisition and data analysis. A total of 939 particles were detected and identified, covering five distinct polymer classes with PMMA being the predominant component.

The magnified view demonstrates that particles of different polymer classes are successfully resolved despite close spatial proximity. Representative mean particle spectra for each of the five detected polymer classes are shown to illustrate their characteristics features in the IR fingerprint region.

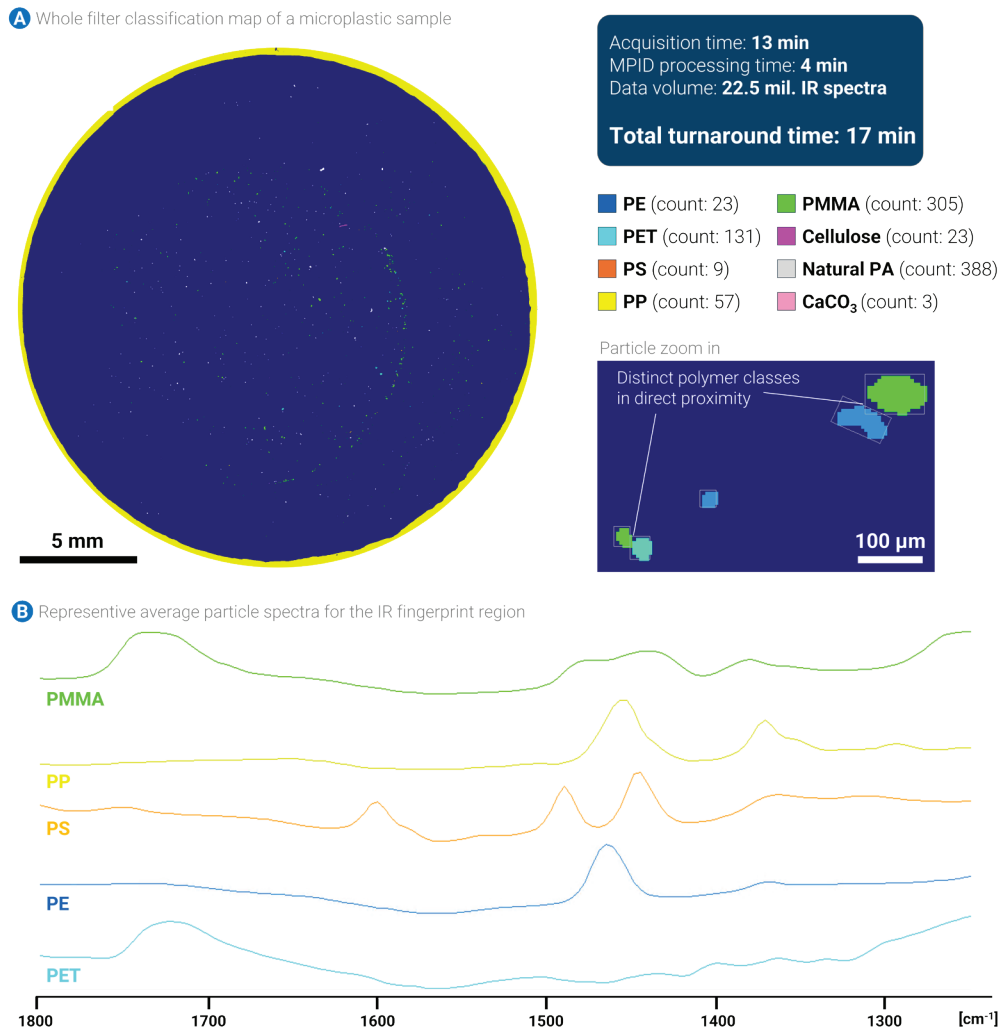


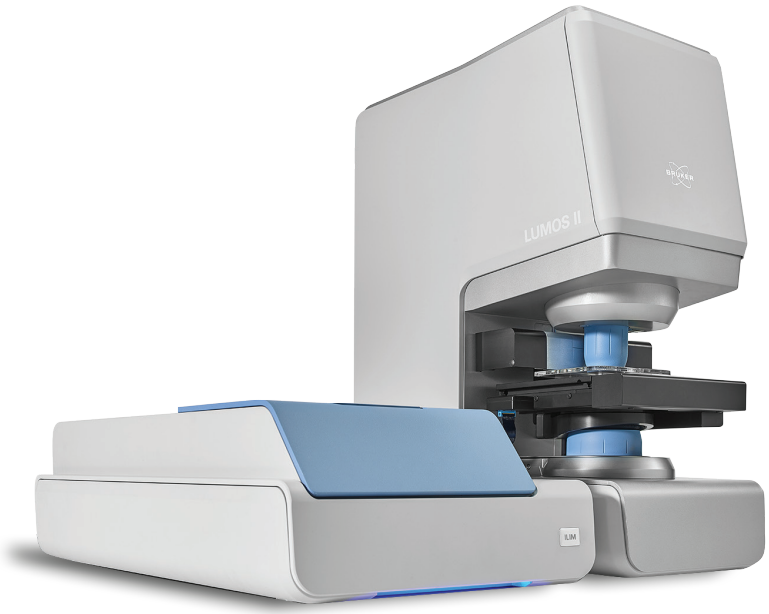
Fig. 4
Results summary for a typical microplastic sample.

Conclusions

ParticlePlus™ serves as an end-to-end solution for microplastic imaging and delivers complete results for entire filters in < 30 min. It saves time and maximizes productivity by providing:

- Routine ready data acquisition characterized by high automation and minimal user input.
- Integrated, AI-empowered data analysis to instantly convert raw data into actionable insights.
- Unmatched sample throughput and reproducible high-quality data, even for non-IR experts.
- Full filter type flexibility, including Anodisc, metal-coated, and silicon membrane filters.

The Fastest IR Microscope Ever Built: LUMOS II ILIM



MEET THE LUMOS II ILIM

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Bruker Optics GmbH & Co. KG
info.bopt.de@bruker.com

bruker.com/optics

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