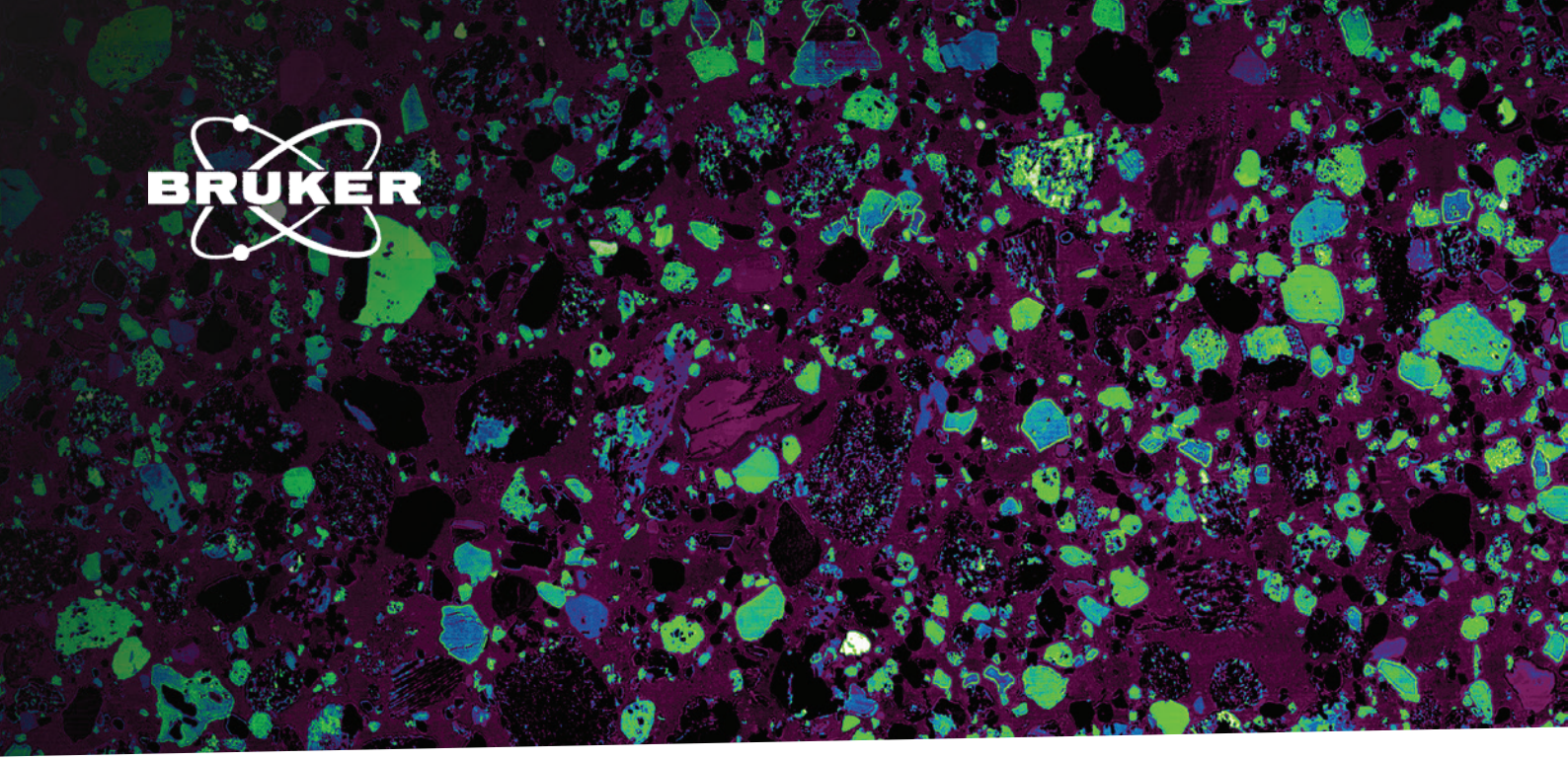


IR LASER IMAGING MICROSCOPES

The TabletPlus™ Workflow

Making Pharmaceutical Tablet Imaging a Turnkey Solution

IR Laser Imaging for Tablet Analysis

Infrared Laser Imaging (ILIM) achieves rapid spatial molecular profiling of ingredients in pharmaceutical tablets. When paired with the TabletPlus™ workflow it transforms tablet analysis into a complete, high-throughput solution with instant results. The software automates data acquisition for tablets and integrates artificial intelligence (AI)-driven data analysis to reveal the composition and spatial distribution of each ingredient for any type of tablet.

System, Setup, and Methodology

The TabletPlus™ workflow is designed for IR Laser Imaging Microscopes. For this study, we utilized the following setup:

- **Tablet Sample Details**
  A commercial tablet (~5 x 12 mm, 5 ingredients) was de-coated and its surface smoothed using ultrafine polishing paper (grain size <10 µm). Pure reference substances of each ingredient were pressed into pellets by a std. pellet press to acquire reference spectra.

- **Mesaurement Setup**
  The LUMOS II ILIM tablet imaging microscope was used in these experiments. Automated data acquisition used TabletPlus™. Laser wavelength was tuned with a spectral step size of 8 cm^{-1} across the MIR fingerprint region of 950 to 1800 cm^{-1}.

- **Data Analysis Tool**
  TabletPlus™ was configured with SampleFinder and TabletAnalyzer, enabling automated hyperspectral acquisition with immediate processing and evaluation.

Creating Work Items

First, the workflow with the according AI-classifier for the sample tablet is selected. Users can choose from existing recipes or build custom classifiers by selecting pure component references from the library (Fig. 1A). The software comes with a *model builder* which applies state of the art machine learning methods to train a fully connected artificial neural network for the required recipe. The reference library itself is fully customizable, supporting the addition of new excipients or active pharmaceutical ingredients (APIs).

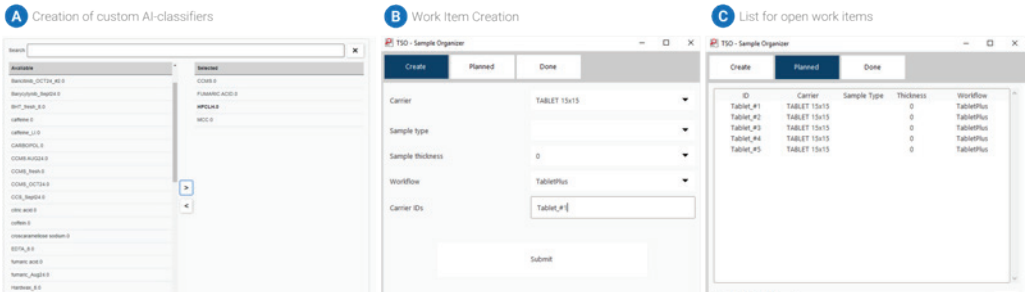


Fig. 1
Creating AI-classifiers and work items in TabletPlus™.

For each sample a work item is created by assigning the corresponding workflow to the sample ID (Fig. 1B). Depending on its status, work items are listed under the 'Done' or 'Planned' tab, where they can be accessed, loaded, or restarted at any time (Fig. 1C). This allows easy scheduling and keeping track of routine analysis tasks.

Automated data acquisition for up to three tablets

After placing the tablet sampling plate (Fig. 2A), each work item run begins with the stage moving to the tablet sample plate's built-in reference standard and performs automatic background calibration. To ensure consistent laser focus and highest quality spectral data across the whole tablet, height variations and sample tilt must be taken into account.

This is done by calculating an optimized focal plane (heat map in Fig. 2B) and automatically adjusting the z-coordinate during measurement. The sample stage then sequentially moves to focusing positions (FP) on the specimen, that match typical tablet shapes and sizes (Fig. 2B).

These predefined and/or custom focusing positions can be adjusted along the z-axis using the live IR view (Fig. 2C). The IR live view has a 1.7 × 1.7 mm field of view (FOV) and a tunable wavenumber range of 950–1800 cm^{-1}. Usually, ~1050 cm^{-1} yields excellent sample–background contrast. An overview image at 1050 cm^{-1} is automatically acquired for each tablet sample position (Fig. 2B, grey rectangle).

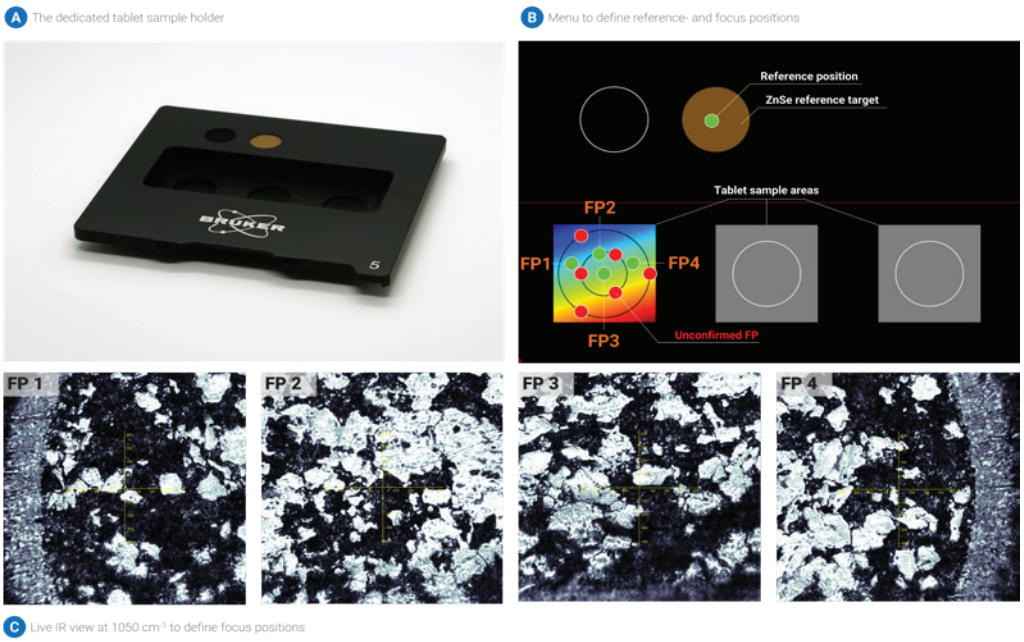


Fig. 2
Defining focus positions and acquiring an overview image for the tablet sample areas.

Based on the overview image, the SampleFinder plugin automatically detects the boundaries of the tablet, sets-up the sampling grid, and starts the hyperspectral acquisition without any user-input (Fig. 3A). For the tablet shown here, 27 measurement tiles (each 1.7 x 1.7 mm) entailing 4.3 million full fingerprint IR spectra were acquired in just three minutes (Fig. 3B).

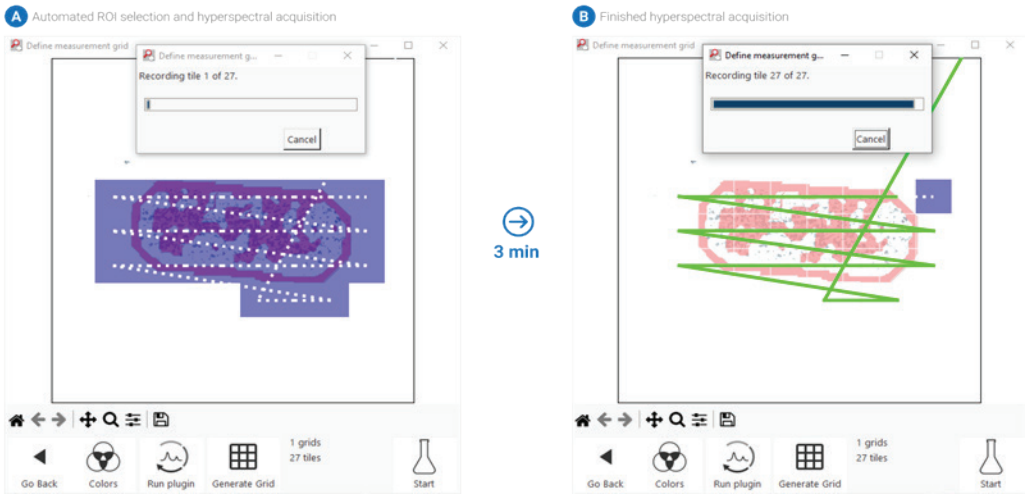


Fig. 3
Automated hyperspectral acquisition for the whole tablet.

Onboard Data Analysis Tools for Immediate Insights

Upon finished acquisition, the data is automatically analyzed by Bruker's AI-classifier, assigning a chemical idenity to each pixel according to the pre trained neural network. Users can also integrate their own data analysis plug-ins via a well documented Python interface.

Tablet size influences total processing time (~30 seconds to 3 minutes). The automatic data evaluation creates a color-coded segmentation map that visualizes the spatial distribution of each component and enables interactive result review evaluation through zooming, color adjustments, component removal, and classification thresholds modifications (Fig. 4).

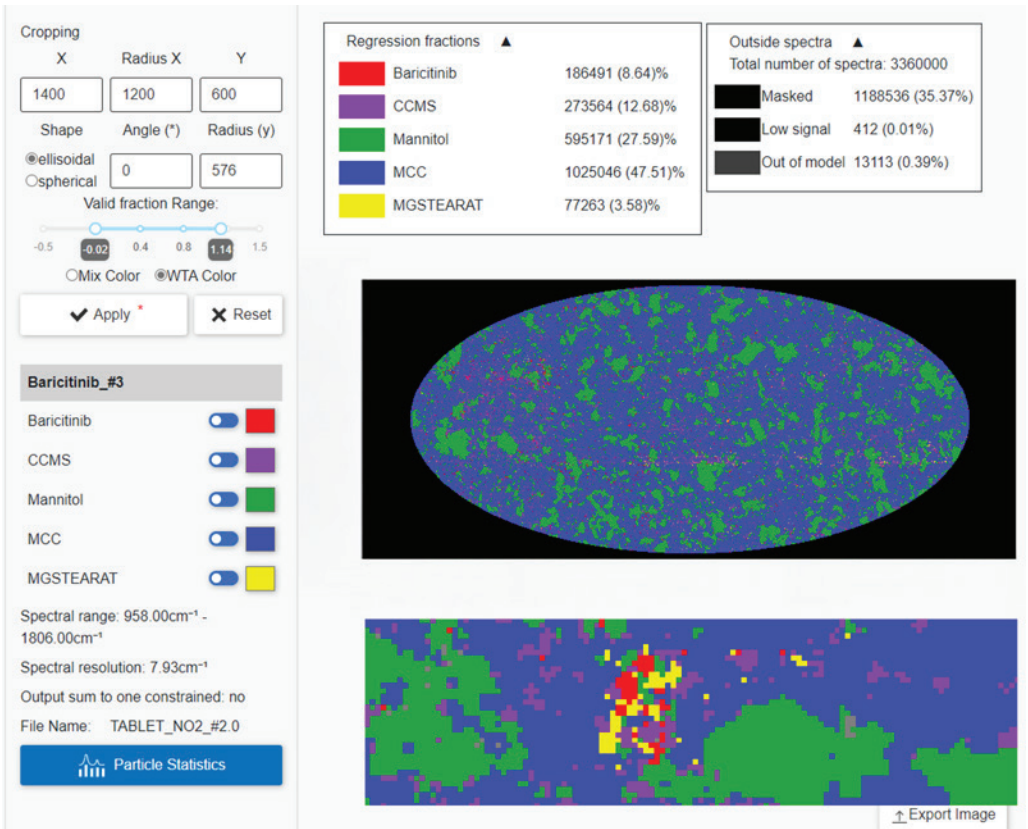


Fig. 4
AI-driven classification results with interactive segmentation map and quantification table.

The relative quantities of each component are expressed as fractions of the total pixel count as derived by the AI-model. For technical assessment, the number of unclassified pixels and those with low signal-to-noise ratio are also provided. The classifier further groups connected pixels with matching chemical identity into particles.

Particle size distribution is displayed as a bar plot (Fig. 5) and is can be exported in CSV format. The finalized results are documented in a standardized PDF report for each tablet. Additionally, raw data is stored in the open-source .zarr format for easy access with external software tools.

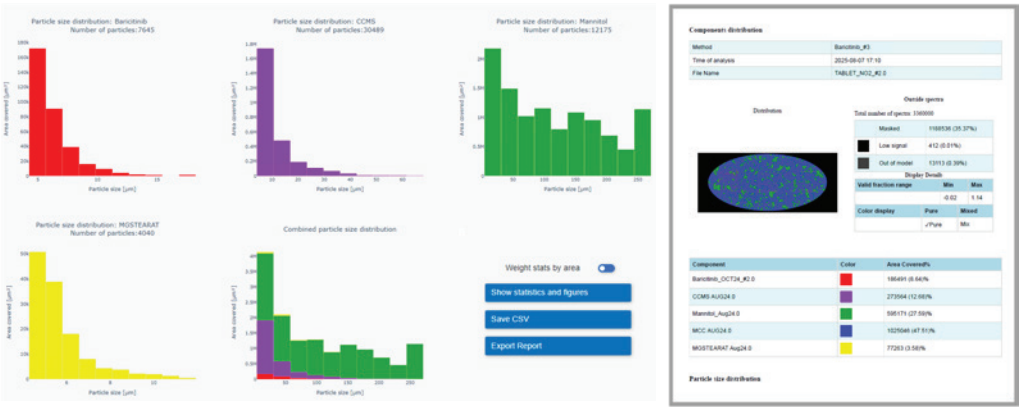


Fig. 5
Overview of the particle size distribution of API and excipient of individual ingredients (left) and report generated from the software (right).

Conclusion

TabletPlus™ serves as a complete solution for pharmaceutical tablet imaging and delivers comprehensive results for any tablet in ≤ 10 minutes. It values time and maximizes productivity for pharmaceutical tablet imaging and classification by providing:

- Routine ready data acquisition characterized by high automation and minimal user input.
- Creation of custom AI-based classifiers for any type of tablet.
- Onboard analysis to instantly convert data to insights within minutes.
- Maximized sample throughput and reproducible high-quality data within and between projects across different operators – including non-IR experts.

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