



FRITSCH Milling & Sizing Brings a Century of Milling Experience now into the Cannabis Industry

What happens when you combine a fourth-generation family business, a century of engineering excellence, a 10,000-year-old medical plant, and an industry worth billions?

The answer: a precision standard for cannabis biomass milling, with optimized and proven methods from one of the world's oldest and most respected laboratory mill manufacturers. By ensuring far greater product integrity and consistency than current analytical and processing methods, FRITSCH's tools enable extractors and manufacturers to create increased yields and ROIs for their business while delivering higher-quality, premium products for the rapidly growing market of medical cannabis patients and consumers.

"We approach the cannabis industry with the same scientific precision we bring to every other industry we serve," says Melissa J. Fauth, President & CEO, Fritsch U.S. "Our professional tools and instruments bring cannabis processing out of the greenhouse and onto the cutting edge of the modern laboratory and production suite. FRITSCH's instruments achieve both qualitative and quantitative leaps forward by providing precision control and parameter fine-tuning for particle size control in plant processing pipelines. Here's how this new vision of the industry's future will change the way medical cannabis is processed, both in the US and around the globe.

"FRITSCH one of the leading manufacturers of application-oriented laboratory instruments worldwide for particle sizing and sample preparation," says Josh Crossney, CEO and founder of Cannabis Science Events. "They are a Founding Sponsor of the Cannabis Science Conference, and together we are partners with a shared vision to improve laboratory testing."

"When I first started in this industry," Crossney says, "cannabis QC and research labs did not fully understand the importance of milling nor homogeneous samples. Melissa Fauth and others at FRITSCH have worked tirelessly to educate these labs through presentations, exhibitions and even demonstrations at our Canna Boot Camps. Together we have advanced cannabis science and improved lab testing. "

Preserving the integrity of the key actives

For more than five years, beginning in North America, FRITSCH has collaborated with and provided precision cannabis milling equipment to companies throughout the world. Their PULVERISETTE line of cutting mills are specifically optimized for biomass processing, utilizing cutting chambers, knives, and airflow with specialized geometries, designed to mitigate heat and physical stress on plant samples while maintaining the chemical profile. Unlike conventional grinders and shredders, FRITSCH mills provide laboratory precision in particle size uniformity, making these systems ideal for high-quality commercial cannabis production.

"Our foundation and values come from a family business culture established through long term partnership," says Fauth. "That enables us to deliver individually configured instruments and application support from a single source — while offering a personal guarantee of the quality of every product and service we provide to our partners and collaborators. "A true milling operation with precision cutting is far superior," says Thomas Rosengren, director of extraction and production at Flower One Holdings. "It maximizes yields of the components we most care about targeting and preserves the integrity of the key actives — flavonoids, cannabinoids, and terpenes — which are located primarily in the trichomes. These chemical compounds give the plant its unique features and effects."

Additionally, Thomas points out that historic grinding of biomass to reach fine particles is a common and unfortunate occurrence in the extraction process. It exerts mechanical forces which destroy and oxidize the most valuable portions of the plant. Grinding and shearing introduce degradation of the fragile trichomes, as well as rupture of the cellular structure, immediately diminishing the API's availability in the finished product.

Further challenges

“The secondary challenge with these methods,” Thomas added, “is that byproducts and contaminants are created, setting the stage for increased extraction yield of these undesirable components – demanding additional refinement and cost burden to produce high quality extracts.”

Thomas emphasizes the importance choosing carefully when building an advanced manufacturing process. “Working with technology partners such as FRITSCH who optimize instruments focused on experience for other highly regulated industries, has proven invaluable.” The level and diversity of technology, plus the sophistication of the Flower One’s flagship extraction facility in Nevada, has created a natural collaboration for advancing the development stages of process control and automation for milling. “Handling and demands of manufacturing, especially for processing thousands of pounds of sizeable meristem colas, provides the unique opportunity to institute new controls in the continual drive for process excellence,” Thomas explains. Melissa Fauth added “In working with Flower One and understanding their needs for growth and operational control, we engaged with them to participate in our process expansion project for material handling, monitoring, and conveyance through our partnership with Sample Automation, LLC, and engineering specialist Andrew Winson.” FRITSCH’s and Sample Automation’s work with Thomas are focused on Flower One’s desire to achieve continuous improvement on quality production and work flow automation, thereby reducing or eliminating specific touch points, potential for degradation or loss of yields. To that end, the Flower One team has enjoyed the process of prototype testing, system upgrades, and modifications to handle this coveted feed stock morphology. FRITSCH continues to manufacture precision milling systems and particle analysers for a wide range of industries, including food, pharmaceuticals, agriculture, industrial materials, and nanotechnology — along with aerospace, energy, 3D printing, and high-tech additives where particles size is of critical importance.

Transforming the perception of how cannabis is prepared

FRITSCH’s laboratory instruments have helped transform industry perception where quality analysis and production have increased focus on evolving regulatory oversight. FRITSCH Mills, optimized to meet the challenges of cannabis’ physical properties, deliver consistent, reproducible and homogeneous particle size using a range of good laboratory practice (GLP) and good manufacturing practice (GMP) principles — precisely the same principles utilized in the design of commercial equipment for leading pharmaceutical and industrial companies where SOP oriented operation is required.

This revolutionary line of mills and analysers bring an unprecedented degree of control and precision to the cannabis processing industry. In sharp contrast to traditional tools like trimmers, blenders, and sifting screens, FRITSCH’s milling and sizing systems were engineered for professional laboratory and specialty process applications. These instruments deliver the same standards and level of accuracy, consistency, and product integrity as leading pharmaceutical manufacturing pipelines, where process repeatability and product uniformity are paramount.

Cannabis milling with FRITSCH instruments

FRITSCH’s precision milling processes yield pharmaceutical-grade material for premium extracts, pre-rolls and homogenized isolates. The company’s high-throughput mills enable processors to increase the turnover rate of each mill in the processing line, while simultaneously fitting more plant material into the extractor column. Furthermore, the instruments’ stainless-steel surfaces are designed to minimize heat and stickiness while remaining easy to clean between each batch.

These performance enhancements combine to deliver significant time savings and operational cost reduction — ensuring greater batch consistency, as well as batch-to-batch reproducibility. At the same time, FRITSCH’s instruments help improve extraction yield and quality, regardless of whether the processor chooses to grind plant material coarsely or finely. All these benefits make the consistency of the final product easy to validate. This tight degree of control helps collectives optimize the efficiency of each extraction, and maximize the calibre of every product that emerges from their processing pipelines.

Extraction of cannabis material using FRITSCH milling systems

Because FRITSCH milling products are continuous milling systems — as opposed to closed-batch systems like blenders or wire trimmers — they exert no heat load on cannabis material, effectively preserving all cannabinoids and terpenes. These findings come from Dr. Markus Roggen’s laboratory, Complex Biotech Discovery Ventures, Ltd. — an independent research laboratory focused on cannabis process optimization. Roggen’s research has shown that milling dried cannabis in preparation for extraction does not lead to cannabinoid degradation or terpene loss, when using the FRITSCH Universal Cutting Mill PULVERISETTE 19.

FRITSCH laboratory mills deliver an average throughput of 0.5-2 kg, on average, of dried flowers per minute —though individual performance may vary based on moisture content, nature of starting material, feeding method, and desired final particle size. This represents a significant improvement over the limited throughput of traditional cannabis milling methods, both in terms of instrument turnover time and in terms of capacity per batch. In crucial moments between batches, all FRITSCH devices are designed to be easy to clean, saving valuable reconfiguration time. All product cutting surfaces are composed of stainless steel, which prevents plant matter from sticking. Additionally, cutting chambers open up completely to allow easy access to all areas, enabling full sweep-outs to be completed in a matter of seconds.

“The particle size and shape of the raw material has an important effect on cannabis extraction efficiency,” Roggen says. “This fact is commonly overlooked by the industry. Our research has shown that small and consistent particle size increases the extraction speed and precision in supercritical CO₂ instruments. Additionally, those small particles also packed denser into the extractor column, giving a larger load capacity for each run. With other common milling techniques, we were not able to match those efficiencies”

Particle Characterization Impact and Contributions to the Cannabis Industry

As a counterpart to its milling instruments, FRITSCH also offers particle characterization instrumentation. Particle sizing is needed in a variety of applications in the cannabis industry. Producers seek to confirm particle size of their milled cannabis flower for reliable pre-roll manufacturing or to ensure an efficient extraction.

An analytical laboratory also requires particle sizing in their validation of sample preparation. Finally, particle size and crystal shape are important factors in medical cannabis products and CBD isolate manufacturing.

FRITSCH’s innovative laser particle size analysers use a reverse Fourier optical system — pioneered and patented by FRITSCH more than 35 years ago — to deliver precise size characterization of materials down to the low-nanometre range



Fig. 1: Laser Particle Sizer ANALYSETTE 22 NeXT

The **ANALYSETTE 22** is the ideal instrument for measuring range of 0.5 – 1500 µm. FRITSCH instruments are found in a wide variety of applications, from research and development to quality control. In the cannabis and hemp industries, particle size measurements are important for quality control for example of CBD isolate materials. This data helps ensure the particle size is correctly adapted to produce maximum product benefits, such as bioavailability.

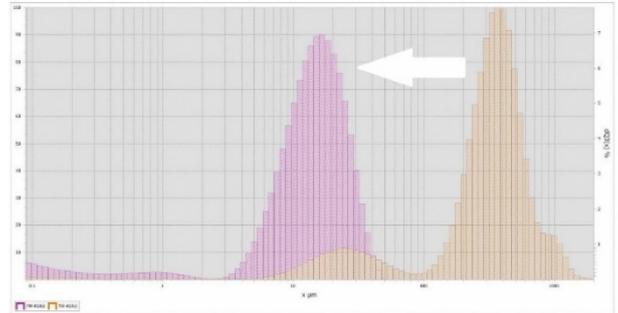


Fig. 2: Typical application of CBD isolates

Dynamic image Analysis

Dynamic image analysis utilizing the **ANALYSETTE 28 ImageSizer** (which offers a measuring range of 20 µm to 20 mm) provides size distribution and particle shapes. This modular instrument offers 19 different parameters describing particle shape, from cross section µm² to circularity.

Fig. 4 on the right shows particle size analysis results using the ANALYSETTE 28, comparing results of a blender to different size PULVERISETTE 19 sieve cassettes: Extraction efficiency for different particle sizes. All other inputs are identical e.g. type of material, weight of material (0.2 kg) extraction parameters like temperature (34° C) pressure (124 bar), runtime (6 hrs).

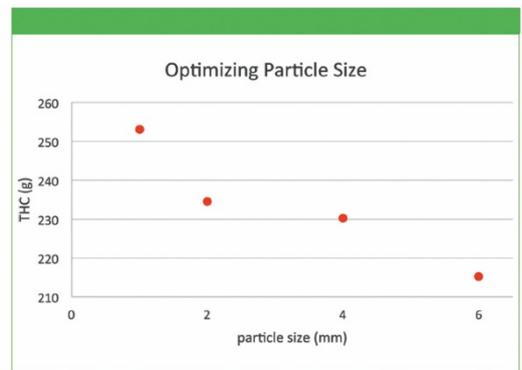


Fig. 3: Extraction efficiency for different particle

Complex Biotec Discovery Ventures, the laboratory of Dr. Markus Roggen, has undertaken studies into CBD crystallization. Their work has identified specific conditions required for the information of CBD crystals of various shapes and sizes, customized to specific applications. “Having a FRITSCH ANALYSETTE at hand to quickly analyse the different CBD crystals was instrumental to delivering the research results to our customers in time,” says Roggan.

FRITSCH Laboratory Mills – an overview

FRITSCH’S **Variable Speed Rotor Mill PULVERISETTE 14 classic line** is ideal for, ideal for flower and leaf samples from 2 to 120+ grams — or up to 10 kilograms with the optional Cyclone collector attachment. Configured as a continuous milling system, the PULVERISETTE 14 *classic line* allows constant feeding of material, as well as active removal of material, from the rotor area in as little as a fraction of a second. Because the homogenization occurs so quickly, and the material is actively removed, the process leaves no time for frictional temperature increase to cause chemical degradation.

All of the contact surfaces are composed of stainless steel — or food-grade plastic vacuum hose for the Cyclone — and are easy to clean thoroughly between batches, reducing the likelihood of cross-batch contamination. A variable-speed motor and a range of sieve rings provide full control over particle size output, offering options to grind plant material more coarsely or more finely, depending on the specific application for which each batch is intended



Fig. 4: Variable Speed Rotor Mill 14 PULVERISETTE 14 *classic line*

Cryogenic grinding

For homogenization of edibles and samples, the **Vibratory Micro Mill PULVERISETTE 0** and the **Knife Mill PULVERISETTE 11** both provide powerful cryogenic milling. They can embrittle edibles and samples directly in liquid nitrogen or with dry ice, creating a homogeneous powder for representative sampling in minutes.

The PULVERISETTE 0 works with edibles and samples up to 50 + grams, depending on their matrix, and its adept at handling flower and leaf samples from two to 10 + grams.

The PULVERISETTE 11 capacity has a full range of < 10 ml to 1400 ml, easily managing most any difficult sample — wet, dry, moist, tacky, hard, or fibrous — with disposable and reusable grinding set configurations. It can also handle samples up to 300 + grams of flower, leaf, seed, and edible samples up to 30 + grams, utilizing single-use grinding vessels in a range of < 10 ml-100 ml volume. This powerful knife mill also provides the ability to create and save standard operating procedures (SOPs) — greatly reducing the time investment of reprogramming and reconfiguring the instrument during alternation between different grinding procedures.



Fig. 5: Knife Mill PULVERISETTE 11

Universal Cutting Mill PULVEIRSETTE 19 – variable speed 300 - 3000 rpm

When larger-scale milling is needed, the **Universal Cutting Mill PULVERISETTE 19** enables processors to optimize particle size and distribution for CO² or EtOH extraction yield. Its variable-speed motor delivers 300 to 3000 RPM. Designed with GLP and GMP in mind, the PULVERISETTE 19 offers adjustable, controllable particle size output with an extremely tight particle size distribution.

The performance of the PULVERISETTE 19 is highly reproducible regardless of the end user’s individual expertise. Its high-throughput system enables continuous processing one to five pounds of material per minute, on average. The mill is dust-free and easy to clean. Its Cyclone separator also provides effective heat mitigation, preventing resin build-up and maintaining the integrity of the final extract or plant product. The US cannabis industry has rapidly grown from a collection of small start-ups to a collection of vertically integrated, scientifically minded firms.



Fig. 6: Universal Cutting Mill PULVERISETTE 19

FRITSCH’s mills and analysers are hand-crafted and machine-tooled to meet the demands of this new generation of purveyors and cultivators of medical cannabis — from speed and efficiency to consistency and product quality.

Blake Grauerholz, director of extraction at OutCo in San Diego, California, says, “The PULVERISETTE 19 not only mills cannabis material quickly, but also helps to improve the throughput and yield, meeting the unique goals of our product line and extract composition. It allows us to custom tune, enhance, and enrich our cannabis oils with the target molecules we desire within our extraction process. There is no waste nor dust observed and the mill is both quiet and reliable. The FRITSCH team even went that extra mile to help us with the implementation and troubleshooting to identify an alternative rotor geometry option that best suited the physical properties of our biomass.” Currently, FRITSCH maintains active collaborative relationships with a number of cannabis collectives throughout the world.



Company representatives provide in-person consultations, assessing the needs and workflows of each processing facility, and collaborate with purchasers to find the ideal laboratory instruments for each facility’s capacity and workflow. “We manage all our client relationships directly,” says Fauth.

“And we make the same promise to every one of our customers: to keep delivering the innovative products and constructive solutions their business demands, while placing the highest value on long-term partnerships and inter-company collaboration.”

Solution-driven partnerships

The company’s engineers regularly share their practical know-how in professional seminars and hands-on workshops, demonstrating exactly how each instrument functions, and answering questions as needed. Furthermore, FRITSCH offers ongoing after-sales service and support, including a supply guarantee for a wide variety of common spare parts. In fact, “Shimadzu Scientific Instruments (SSI), Fritsch Milling & Sizing, and six other companies have been traveling around the US for the past three years, offering free local training for to anyone interested in working in the hemp or cannabis industry,” says SSI’s General Manager, Dr. Bob Clifford. “The seminar includes grinding the biomass through sample preparation to analytical results and big data analysis with LIMS/LIS systems. Class size is limited to 50-75 people depending on the venue.

If you would like a local seminar in your area please contact FRITSCH.

FRITSCH’s vision for the future of the US cannabis industry

Through the use of precision milling equipment, laboratory-grade analysis, and enhanced efficiency, FRITSCH is leading the cannabis industry with an integrated suite of innovative new solutions. These approaches are already helping leading cannabis collectives improve their efficiency and product consistency, while optimizing the quality and value they provide to the patients and clients they serve.

FRITSCH’s experts continue to discover optimal solutions for a variety of specialized challenges, using laboratory and processing equipment that is perfectly adapted for the unique properties of the plant material to be processed. The results are enhanced accuracy and consistency throughout the processing pipeline, helping create higher-quality cannabis products for the increasingly competitive medical market.

“Our approach remains focused on simplifying the work our customers do, and increasing the efficiency, consistency and quality of those processes,” says Fauth. “As in so many other industries, we stay ahead of the cannabis curve by continuing to recognize changing market demands, and to help our customers convert those demands into new opportunities through constructive problem-solving.”

Even in today’s rapidly evolving medical cannabis industry, FRITSCH’s overall vision upholds the same standards on which they’ve built their reputation for more than a century.

They continue to think and work as a family business, crafting precision German-made instruments with extensive in-house production expertise. In fact, the firm’s leaders continue to invest into future product development, making sure today’s clients and customers are effectively prepared for tomorrow’s challenges.



Fig. 7: Cannabis oil

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