



# COMPLETE SOLUTION FOR PMDI PRODUCTS: FROM DEVELOPMENT TO QUALITY CONTROL TESTING

In this article, Heli Chauhan, Senior Applications Chemist, Proveris Scientific, outlines the major challenges encountered in testing pressurised metered dose inhalers, and how Proveris' portfolio of instruments can be an invaluable addition to the testing workflow.

Pressurised metered dose inhalers (pMDIs) are currently the largest revenue-generating segment in the asthma and chronic obstructive pulmonary disease (COPD) drug delivery devices market and are expected to maintain this position until 2020.<sup>1</sup> This results in extensive testing needs for pharmaceutical companies developing and manufacturing these products. The large volume of complex tests presents many challenges. With industry-leading instruments, support and lab services, Proveris provides a complete solution for pMDI testing throughout the life of the product.

## KEY CHALLENGES IN PMDI TESTING

Today, the industry faces a number of challenges in testing pMDI products. Robust testing methods ensure the integrity of data over time. Consistent actuation parameters are important for accurate and reproducible

actuation of devices. Actuating devices by hand is not consistent over time and can introduce variability from person to person. Figure 1 demonstrates the observed variation in results from manual actuation, showing the stroke length, actuation velocity and hold time as recorded from the manual actuation of a pMDI product by five testers. The variability in results exists from person to person as well as across different shots (x axis).

Automated actuation of devices eliminates the variability observed in manual actuation altogether. Vereo<sup>®</sup> actuators, controlled by Viota<sup>®</sup> software, ensure that the actuation parameters (velocity, stroke length, hold time) are controlled in a user-defined manner and are consistent across multiple actuations. Moreover, keeping the actuation parameters consistent throughout, across tests, results in high reproducibility of data. Proveris' software platform offers complete traceability of all actuation events

along with force-position-time profiles to aid in root-cause analysis during an out-of-specification (OOS) analysis.

Since most pMDI products are suspensions, the shaking profile is crucial for accurate dose delivery. Lack of appropriate shaking delivers a high amount of the drug in the early doses followed by very little to no drug towards the end of product life. As can be seen in Figure 2, in non-shaking

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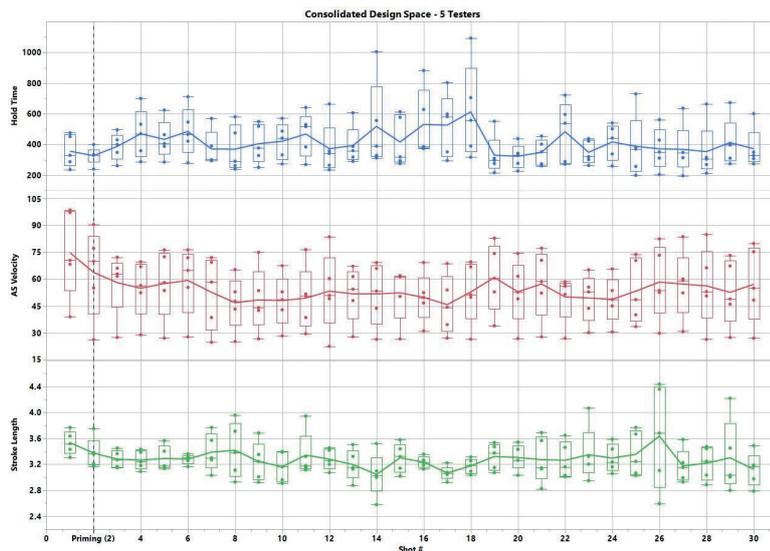


Figure 1: Range of actuation parameters recorded for a pMDI product from manual actuation by five testers.

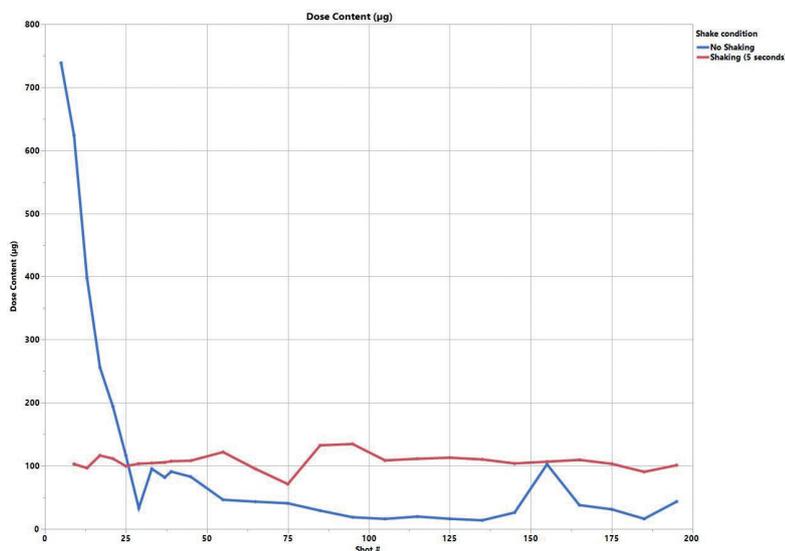


Figure 2: Effect of shaking on the dose content of drug over the life of the product.

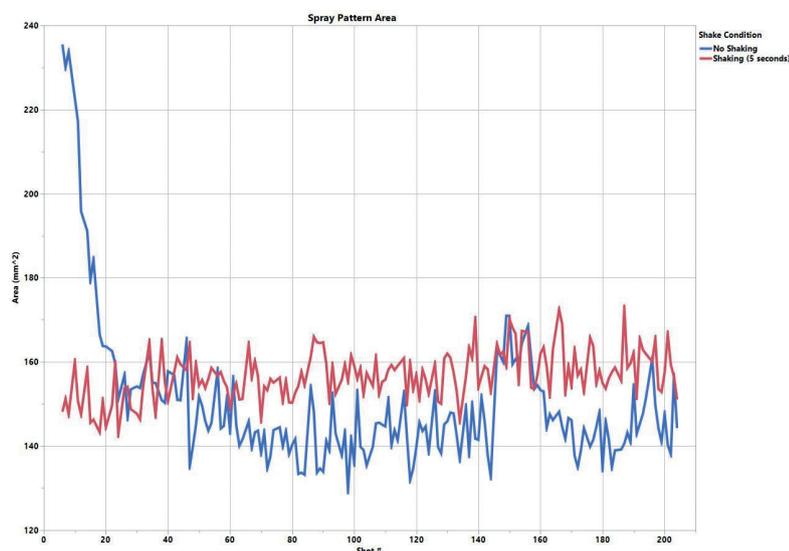


Figure 3: Effect of shaking on spray pattern area over the life of the product.

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conditions (blue line), the amount of dose delivered is multiple times the intended target dose for the first few actuations and then drops over the life of the device. Since the drug formulation and the propellant are not mixed in this scenario, the emitted spray may have a very high concentration of drug formulation and less propellant. In comparison, the doses delivered after five second shaking profiles were more uniform throughout product life. This lack of shaking could be fatal for some patients, should they get huge amount of drug in the initial shots from the device and mostly just propellant afterwards.

The shake-to-fire delay time (i.e. time between shaking the device and its actuation) of a pMDI device is known to play a role in dose content variability.<sup>2</sup> Furthermore, specific shaking profiles are required for certain products depending on the type and number of excipients present.<sup>3</sup> This underlines the importance of determining and performing the proper shaking profile to ensure the correct dose is delivered every time.

The same effect as described above was observed when spray pattern (SP) area was measured using Proveris' Sprayview<sup>®</sup> measurement system over the entire life of the device (Figure 3). Initial high SP area followed by a steep drop was observed for the “no shaking” condition. In comparison, a more uniform SP area was seen for the five-second shake duration.

These observations highlight the importance of shaking properly and reproducibly when testing pMDI devices both during development and as a quality control measure. Proveris instruments provide the user with the flexibility of programming the shaking angle, frequency, shaking duration and shake-to-fire delay so that all the devices have a uniform shaking profile for all the required tests. This will also eliminate shaking as a cause for inconsistencies in dose content and spray performance results.

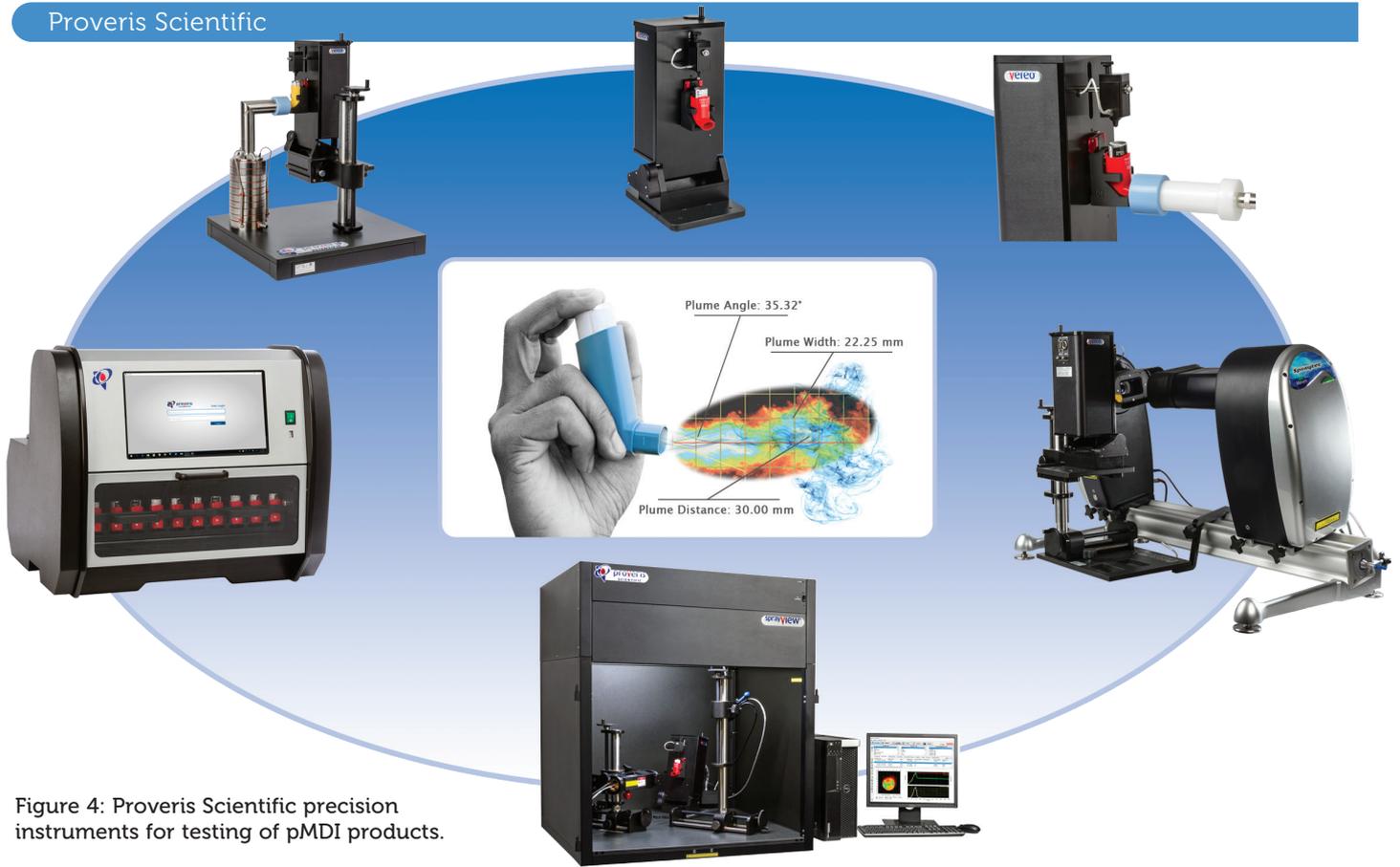


Figure 4: Proveris Scientific precision instruments for testing of pMDI products.

**PROVERIS AS A PMDI TESTING SOLUTION PROVIDER**

Proveris aims to provide a complete solution for testing pMDI products with its precision instruments (Figure 4). The Vereo® SFMDx Automated Actuators are flexible and fit seamlessly into multiple testing workflows, such as:

- Shot weight measurement
- Dose content uniformity
- Aerodynamic particle size distribution (cascade impaction)
- Particle size distribution (laser diffraction)
- Spray pattern and plume geometry
- Fire-down of sprays between testing.

**Spray Pattern and Plume Geometry as a Prescreening Tool for Clinical Trials**

Spray pattern measurements from the SprayVIEW® instrument are a valuable screening tool during early development. The spray pattern is sensitive to changes in individual parameters, such as orifice length, orifice diameter and chamber depth, which are crucial design characteristics of the pMDI actuator.<sup>4</sup> Gaining the ability to see the effects of these parameters on spray performance can have a significant impact on successful product development and prevent costly late-stage development failures.

Spray pattern and plume geometry measurements give a substantial amount of

valuable information, irrespective of being a regulatory requirement by the US FDA. To illustrate this, take the measured spray pattern for two pMDI devices using the same canister and only a slight difference in the actuator. As displayed by Figure 5, the spray duration for the two are significantly different (60 ms versus 140 ms).

Further, the plume geometry data and the playback video of the plume from these devices gives a qualitative insight about the direction of the spray. Direction of spray is important to determine during development, as any skew can lead to higher deposition on the sides of the mouthpiece and low

availability to the patient during clinical study, ultimately leading to failure *in vivo*. This quantitative and qualitative set of data can be invaluable for decision making prior to running an expensive clinical study. Proveris also offers lab services that include patient usage studies, device characterisation, formulation/device screening as well as qualitative/quantitative analysis of product performance. These studies can be especially helpful for companies who do not plan on testing in-house but nevertheless want to evaluate the product performance on a small scale or require consulting during early development.

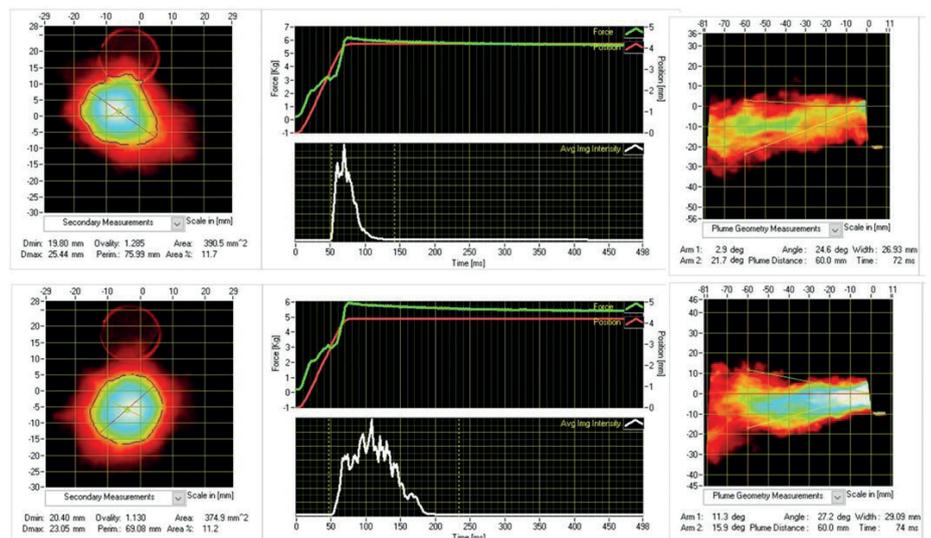


Figure 5: Changes in the spray duration between two identical pMDI devices with slight differences in the actuator.

### Kinaero™ High-Throughput Fire-Down System

The newest addition to Proveris' family of instruments is the Kinaero™ High-Throughput Fire-Down system for pMDIs. Firing down pMDI devices can be tedious and time consuming. Proveris' Kinaero system addresses this issue, capable of firing down either canisters only or entire devices with actuators using specific easy to insert cassettes (Figure 6).

By replicating human use of inhalers, the Kinaero™ system provides reproducible actuation throughout product life. The software platform, with database storage and retrieval is compliant with 21CFR Part 11. Programmable shaking angle, frequency, duration and inter-actuation delay along with multiple modes of actuation (force, position or time based) provides greater flexibility during automated fire down. The compact benchtop model with a large touchscreen display offers the following key features and benefits:

- Automated fire down for up to 10 pMDI devices
- Multiple modes of actuation based on force, position and time
- Programmable shaking angle, frequency and duration
- Self-contained evacuation system that eliminates tedious waste disposal methods
- Updated operation and data management software with database storage and retrieval
- US 21 CFR Part 11 compliant.

Since the entire system is self-contained and requires only AC power, no vacuum or pressurised air connections are necessary. The multi-level filtration system containing high efficiency particulate air (HEPA) and activated carbon filters can withstand tens of thousands of shots before replacement is required. Moreover, no additional cleaning steps are required along with easy replacement of filters and system alerts to remind the user that a filter is due for replacement. The software platform also offers multiple operator levels with differences in privileges depending on whether the user is in an R&D or QC setting. Additional features such as the Break/Resume mode allows the user to pause a method, walk away from the instrument and resume it easily.

The Kinaero™ system fits into the pMDI testing workflow with ease, allowing



Figure 6: Kinaero™ high-throughput fire down system.

users more control over their testing parameters. It also reduces the ergonomic burden on the analyst of firing down multiple devices. The time saved increases the operational efficiency of the lab and reduces testing backlog.

### CONCLUSION

This article described some of the key challenges in pMDI testing, including the importance of consistent actuation and shaking parameters along with the need for traceability for OOS results. Proveris Scientific provides a solution to these issues with its portfolio of instruments that fit into most of the testing workflows, from shot-weight testing and spray characterisation to firing down of devices between tests. Consistent actuation and shaking profiles ensure accurate and reproducible actuation during each run. Along with supporting these workflows, spray pattern and plume geometry results from the SprayVIEW® instrument give insight into product performance early during development, thereby improving the chances for success during *in vivo* studies.

### ABOUT THE COMPANY

Proveris Scientific delivers innovative technologies, services and deep product

knowledge to a worldwide customer base of branded and generic pharmaceutical companies, device manufacturers, CDO/CRO/CMOs and regulatory agencies working with orally inhaled and nasal drug products (OINDPs). Its team of engineers, scientists and service professionals has developed a more complete understanding of the critical quality attributes affecting the performance of OINDPs, and in effectively controlling them from a testing and patient usability perspective.

### REFERENCES

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2. Hautmann J et al, "Effect of Time between Actuation on the Dose Variability for Three Metered Dose Inhalers". Proc RDD Europe 2013 (Berlin, Germany), 2013, Vol 2, pp 429–434.
3. Newcomb A, Farina D, "Understanding the Importance and effects of shaking on pMDI performance". Proveris Scientific Poster, DDL Conference (Edinburgh, UK) Dec 2015.
4. Liao L et al, "Spray pattern: A rapid and sensitive early development tool for respiratory drug products". Inhalation Magazine, Oct 2017.



## Don't waste your time... just your product!



**The new Kinaero™ High-throughput pMDI Fire-down System**

Proveris Scientific's innovative new Kinaero™ High-throughput Fire-down System helps increase your pMDI testing efficiency in Product Development and QC. By replicating human usage of inhaler spray devices, the Kinaero electro-mechanical system ensures reproducible actuation throughout product life.

This feature-rich instrument has taken a unique approach to fire-down with its self-contained evacuation system which eliminates tedious waste disposal methods.

The operation and data management software, with database storage and retrieval ensures compliance with U.S. 21 CFR Part 11.

Programmable shaking, angle, and duration along with the proprietary multiple modes of Force, Position, and Time-based actuation gives greater flexibility during the automated fire-down of up to 10 devices.

Learn more at:  
[goproveris.com/ODD0418](http://goproveris.com/ODD0418)

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