White Paper

Agilent
Trusted Answers

Exploring the Return on Investment, Economic Benefits, and Productivity Increases with the Agilent Ultivo Triple Quadrupole LC/MS

Author

Patrick Batoon, PhD
Triple Quadrupole LC/MS
Product Manager
Agilent Technologies Inc.
Santa Clara, CA

Introduction

The Agilent Ultivo triple quadrupole LC/MS (Ultivo LC/TQ) is an innovative product that aims to redefine the possibilities of mass spectrometry by significantly improving your lab's return on investment (ROI) for LC/MS analysis. The Ultivo was designed with multiple things in mind: size and footprint, ease of use, and speed of maintenance while maintaining the power and capability of a standard triple quadrupole. By combining multiple innovations in hardware and software developed solely by Agilent, the result is a space-efficient instrument that is simple to maintain and quick to deploy, producing answers you can trust.*

This white paper highlights the features and benefits of owning an Ultivo LC/TQ in terms of actual tangible benefits to your lab operations.

**When compared to the Agilent 6410, 6420, 6430, and 6460 triple quadrupole LC/MS*

Increasing lab real estate

Smaller form factor for multiplied throughput

The most obvious and distinguishing feature of the Ultivo LC/TQ is the drastically reduced size of the instrument. When compared with "legacy" instrumentation, the Ultivo is shown to be up to 70% smaller in footprint—freeing up precious lab space for a greater number of instruments or larger sample preparation area.

Based on the size differences shown in **Table 1**, when arranged in the manner shown in **Figure 1**, approximately three units of Ultivo can fit in place of a comparable LC/TQ. In cases where space is limited but throughput must be maximized, this results in in three times the productivity when all instruments are operated simultaneously for analysis.

Table 1. Size comparison of comparable legacy triple quadrupoles

Instrument Model	Dimensions (H×D×W)	Bench Area (D×W)	Bench Volume (H×D×W)
Ultivo LC/TQ	32×88×39.5 cm	3,476 cm^2	111,232 cm^3
6410 LC/TQ	47×66×111 cm	7,326 cm^2	344,322 cm^3
6420 LC/TQ	47×66×111 cm	7,326 cm^2	344,322 cm^3
6430 LC/TQ	47×66×111 cm	7,326 cm^2	344,322 cm^3
6460 LC/TQ	48×66×111 cm	7,326 cm^2	351,648 cm^3

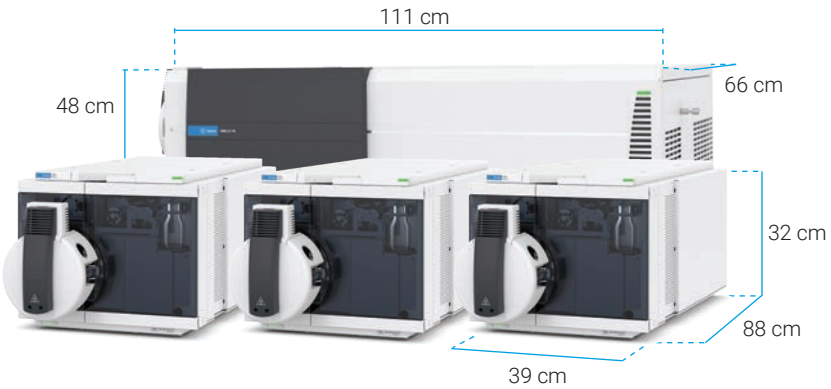

Figure 1. Size comparison of Ultivo vs. comparable legacy Agilent triple quadrupoles

LC module stackability

Oftentimes, LC modules are kept on a separate cart or placed adjacent to the mass spectrometer, expanding the space requirement for full analytical operation (LC and MS). Fortunately, the Ultivo's small form factor is complemented with the stability and strength to support vertical stacking of InfinityLab LC Series modules. By stacking the LC modules onto the Ultivo, the same benchtop area is utilized—allowing labs to capitalize on underutilized vertical space (**Figure 2**).

Figure 2. Ultivo with 1260 Infinity II Prime LC system in the InfinityLab Flex Bench MS

Mobility and enhanced maintenance with InfinityLab Flex Bench MS

When full mobility of the analytical system (Ultivo + LC) is desired, the instrument can be incorporated into the InfinityLab Flex Bench MS (G6015A/G6015B). The InfinityLab Flex Bench MS (**Figure 3**) seamlessly integrates the LC modules (high-pressure pumps, autosampler, thermal column compartment, solvent tray) and Ultivo into a movable unit. Instrument mobility is useful for labs that intermittently require LC/MS capability or would like a single movable unit for lab operations.

Another distinguishing feature of the InfinityLab Flex Bench MS is the retractable bottom tray (**Figure 4**). This allows the Ultivo to slide outward for quicker instrument maintenance or repairs. Most repairs or maintenance operations are designed to be performed from the side panels (as opposed to the top). The area gained when drawing out the Ultivo allows free movement for the field service engineer to operate with swift ease for reduced downtime.

Figure 3. Ultivo with the 1260 Infinity II Prime LC system in the InfinityLab Flex Bench MS

Figure 4. Ultivo utilizing the retractable bottom tray in the InfinityLab Flex Bench MS

Reducing the cost of instrument maintenance

No-vent ion injector capillary maintenance with VacShield

The most common issues involving instrument sensitivity often originate from buildup and accumulation of matrix components in the atmospheric pressure sample introduction region. The component most affected by this buildup is the ion injector capillary, which facilitates desolvation and ion transfer from atmospheric pressure to the mass spectrometer's high vacuum. Traditionally, cleaning of the ion injector capillary required venting the system for its removal, taking multiple hours with numerous steps to be considered.

With the addition of VacShield (**Figure 5**) in the Ultivo, an ion injector capillary can be easily removed for cleaning without needing to shut down and vent the instrument. When a capillary is removed, a sealing mechanism is automatically triggered without user intervention—the user must simply pull. The instrument remains in "standby," sustaining the necessary temperatures and vacuum levels for immediate operation.

With the capillary ion injector removed, the user can simply sonicate the component for a couple of minutes to remove accumulated matrix deposits. Once the cleaning is complete, simple reinsertion of the ion injector capillary can be done to continue operation. This feature drastically transforms a lengthy and involved maintenance procedure that can take up to 14 hours to taking roughly 30 minutes (**Table 2**). This easy maintenance process can be carried out by novice users.

SWARM methodology with scheduled autotune and checktune

Two unique tuning features were added to make the Ultivo quicker to operate when compared to other instruments: SWARM tune and scheduled autotune.

- Initially implemented in the LC/Q-TOF platforms, SWARM methodology applies a rigorous multidimensional statistical approach to drastically reduce time required to optimize and set electrical components. **Instrument autotune times are reduced from ~40 minutes to ~15 minutes**.
- Scheduled autotune and checktune allows tune functions to be performed at regularly scheduled intervals, demonstrated in **Figure 6**. Once scheduled, tune functions execute without any prompting from the user, providing instrument readiness at the start of a workday or at the end of a lengthy sample sequence.

Table 2. Estimation of capillary removal and cleaning maintenance

Procedure	Without VacShield	With VacShield
Cool down to acceptable temperature	15 mins	Not needed
Break vacuum and leak air into the instrument	15 mins	Not needed
Removal and cleaning of ion injector capillary	20 mins	20 mins
Power on and pump down	300 mins (5 hours)	Not needed
Checktune or autotune instrument	8 mins (checktune) 15 mins (autotune)	8 mins (checktune) 15 mins (autotune)
Total time	**358–365 mins (5.9–6.1 hours)**	**28–35 mins**

Figure 5. Use of the VacShield mechanism

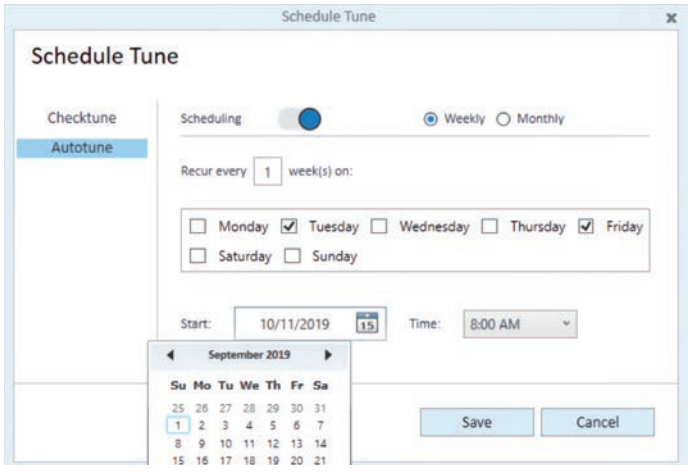

Figure 6. Preview of the Schedule Tune window

Be ready for maintenance with early maintenance feedback (EMF)

Unexpected downtime is disruptive to a lab's operation, especially when sample turnaround time is crucial to the success of the organization. Readbacks from the Ultivo's built-in sensors and counters are summarized in the early maintenance feedback window (**Figure 7**), indicating the health and status of the instrument, similar to a battery indicator on mobile devices. This alerts the user to any potential issues that may arise, pinpoints the user to specific regions of possible failure, and provides alerts when off-interval maintenance service is required.

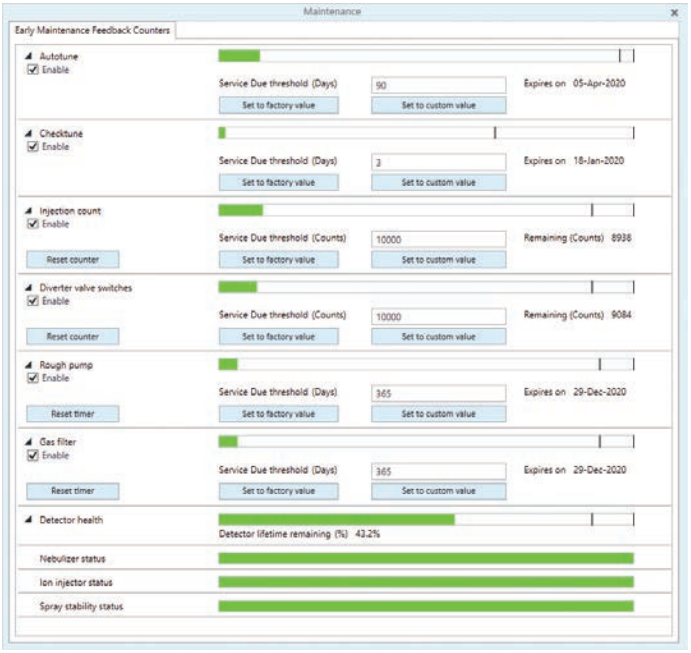

Figure 7. Preview of the early maintenance feedback counters

Reducing the cost of method development and data analysis

MRM optimizer aids in the development of triple quadrupole methods

MRM optimizer (**Figure 8**) is a powerful semi-automated tool that assists with the development of methods from scratch or for further optimization of existing methods. Analyte MRM transitions and optimal parameters can be determined quickly with this software.

After entering a molecular formula and preferred number of product ions, the software will create worklists that explore the various precursor ions, product ions, MRM transitions, collision energies, and fragmentor voltages. Once compounds are optimized, results are summarized in a report and saved as a user database. Optimization results can then be imported directly into an analysis method.

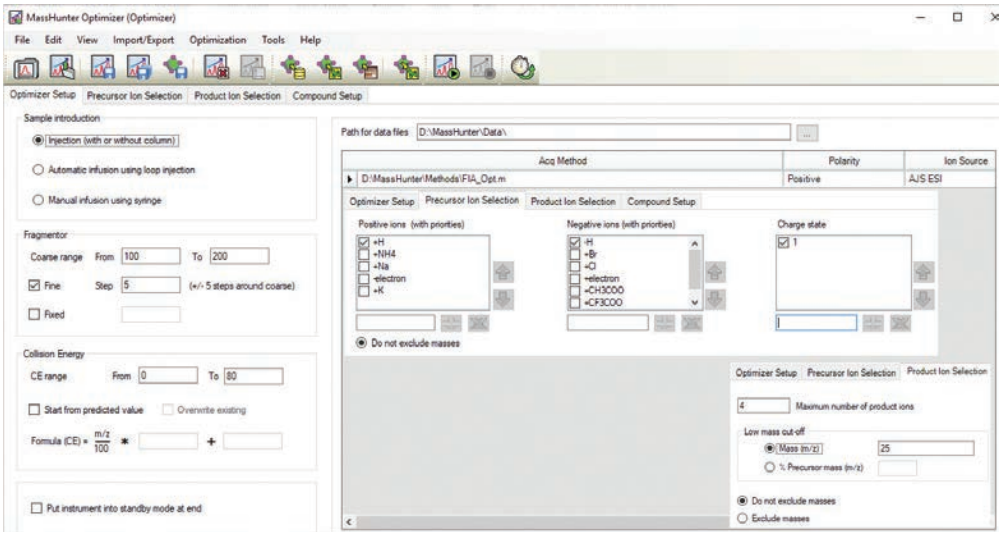

Figure 8. Screenshots of various MassHunter Optimizer features for MRM determination

tMRM databases import predefined MRM transitions

A time-consuming aspect of triple quadrupole method development is determining the appropriate precursor and product ion MRM transitions for target analytes. Avoid having to start from scratch by utilizing Agilent's variety of ***professionally curated*** tMRM databases of compounds in a given application space:

- Pesticides (G1733CA)
- Forensic Toxicology (G1734CA)
- Veterinary Drugs (G1735CA)
- Metabolomics G6412AA)

Each tMRM database contains suggested "primary" MRM transitions in addition to "secondary" transitions for greater compound specificity. Databases integrate seamlessly into the MassHunter Acquisition platform and can be imported directly into the acquisition method. However, for further fine-tuning or confirmation of database values, Fragmentor and Collision energy voltages can be further optimized through MRM optimizer.

Source optimizer builds proper optimization methods

Optimization of the ion source is considered the final step in the method optimization timeline and is one of the most tedious when done manually. Heater parameters need time to properly equilibrate throughout the ion source before carrying an acquisition. With Source optimizer (**Figure 9**), all source parameters can be defined by a range and step size. Once ready, a sequence of methods is created with proper thermal equilibration times inserted between each temperature step. The assistance allows the user to run the ion source optimization sequence overnight and have properly equilibrated source parameter ramps at the start of the next day.

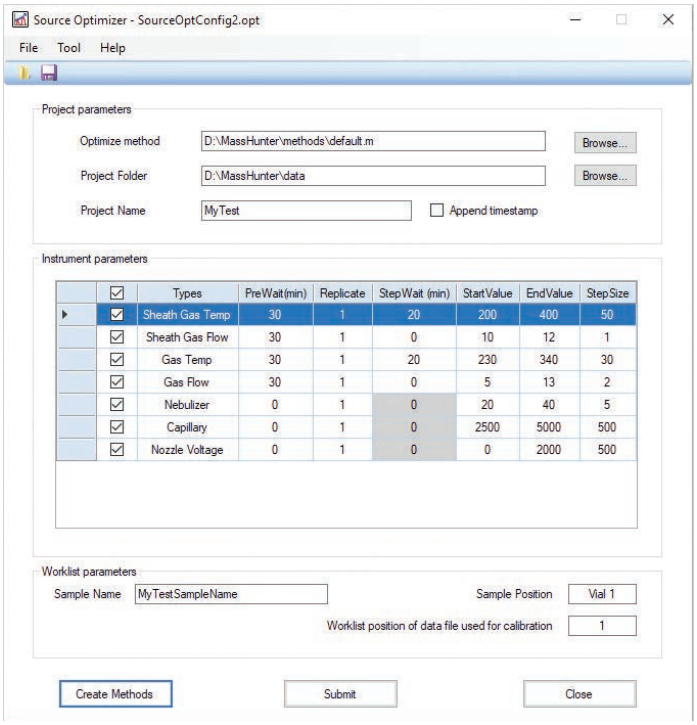

Figure 9. Preview of the Source Optimizer application

Increase data analysis efficiency

Quant-My-Way adds focus to the user interface

MassHunter quantitative analysis software is the premier feature-packed tool for performing quantitative analysis on an Agilent triple quadrupole LC/MS. In the hands of a fully trained expert user, the full suite of tools are available and present for selection. However, this can be intimidating and confusing for nonexpert users. With Quant-My-Way, the expert user can simplify the user interface (**Figure 10**), creating focus to features that matter the most to the organization. With greater focus on only necessary features, user efficiency and productivity gains can be made.

Conclusions

When thinking about the success of your organization, there are more parameters to consider than sensitivity and high performance. Lab space/size, mobility, ease of use, minimal maintenance requirements, and workflow-assisting tools are all important factors for high sample throughput with quality results. The Ultivo LC/TQ was built with these considerations in mind—fusing high performance, robustness, small form factor, mobility, and ease-of-use/maintenance into a tiny-yet-powerful package. With multiple award-winning innovations, you no longer have to compromise between size and performance, you can have it all with the Ultivo triple quadrupole LC/MS.

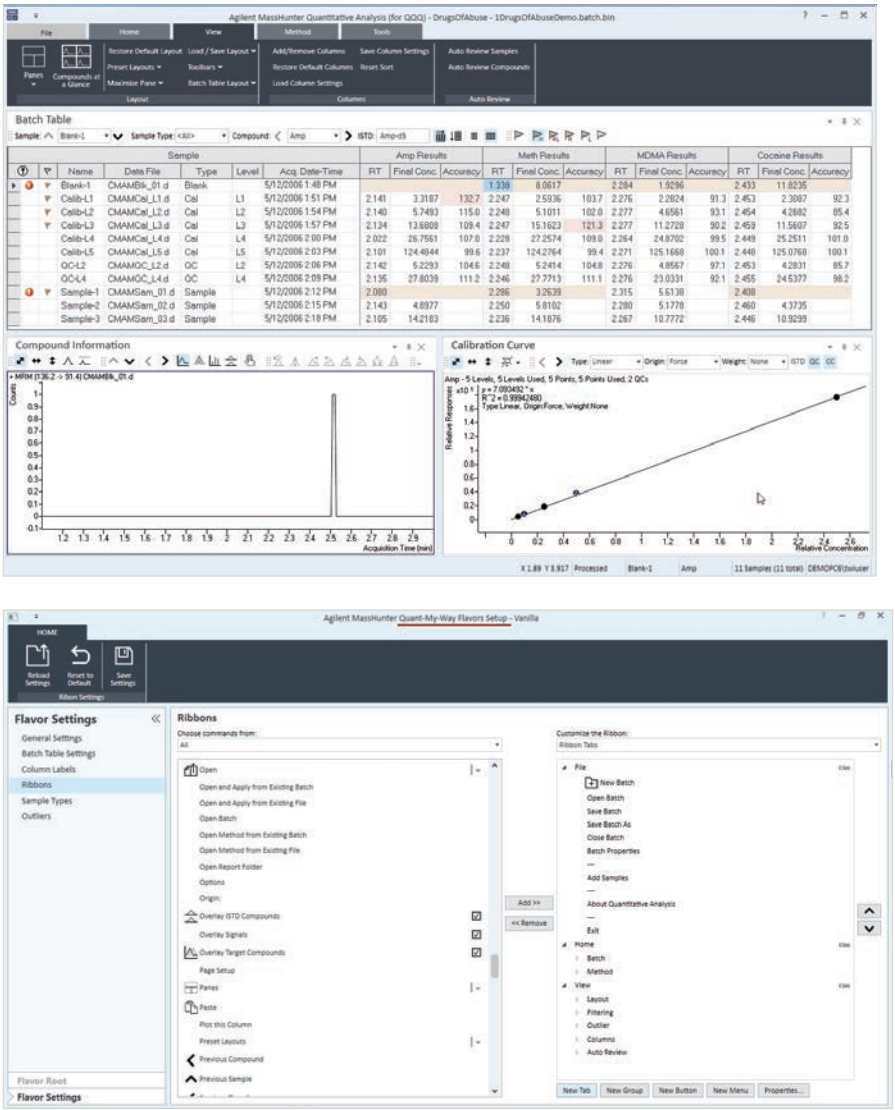

Figure 10. Preview of MassHunter Quant-My-Way, allowing users to customer the top ribbon of their quantitative analysis package.

www.agilent.com/chem/ultivo

DE.5177893518

Printed in the USA, April 1, 2020
5994-1857EN

Agilent
Trusted Answers