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PERSPECTIVES IN MODERN HPLC

# New HPLC Systems and Related Products Introduced in 2019–2020: A Brief Review

This installment describes new high performance liquid chromatography (HPLC) and mass spectrometry (MS) instruments, chromatography data systems (CDS), and related products introduced at Pittcon 2020 or during the prior year. It summarizes their significant features and user benefits.

Michael W. Dong

The Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy (Pittcon) is one of the world's largest conferences on laboratory science. The 71st Pittcon was held at McCormick Place in Chicago from February 29 to March 5, 2020, a week before to the semi-shutdowns of Europe and North America from the spreading Covid-19 virus. Chicago has been the most frequent venue for Pittcon in recent years, with previous Pittcons held in Chicago in 2014 and 2017, in a three-year rotation. Chicago is an industrial, agricultural, financial, transportation, and communication center, as well as the third largest city in the Unites States. The city has 2.7 million residents, and the Greater Chicago area boasts a population of 9.5 million. Chicago is home to 69 of the 1000 most prominent companies in the United States, which include Boeing, Abbott Laboratories, Caterpillar, and Kraft Foods. Nevertheless, one potential issue for this location is the unpredictable weather of this midwestern city near the Great Lakes in early March. We were lucky this year with moderate temperatures and no precipitation, though the meeting attendance was reduced because of travel bans related to Covid.

The technical program remained strong this year with more than 200 technical sessions, plenary lectures, and invited, contributed, or award symposia, as well as workshops, posters, and networking sessions, and approximately 90 short courses. The 3-day exposition, however, was visibly smaller than in the past, with the number of exhibitors from the United States dropping from 630+ in prior years to about 400. The number of international exhibitors was also dramatically reduced due to the travel bans from China and many European countries (1).

## New HPLC, MS, and Chromatography Data System (CDS) Product Introductions for 2019–2020

Although introductions of new ultra-high-pressure liquid chromatography (UHPLC) systems appear to be slowing down (1,2), manufacturers are turning their attention to HPLC system extensions and chromatography data systems (CDS), as well as mass spectrometers for liquid chromatography–mass spectrometry (LC–MS) or direct liquid and solid sampling.

Table I lists new products, ordered alphabetically by vendor, that were introduced at Pittcon 2020 or in the prior year, followed by descriptions and commentaries of each product, categorized as systems, modules, CDS, MS, software, or accessories.

## HPLC and UHPLC Systems and Line Extensions

New UHPLC systems introductions have slowed in the last couple of years as manufacturers have appeared to focus more on HPLC line extensions and customized systems for specific applications (1).

### Agilent 1290 Infinity II Preparative Open-Bed Sampler/Collector

Agilent offers a new extension to its InfinityLab Purification Solutions with the Agilent 1290 Infinity II Preparative Open-Bed Sampler/Collector. This instrument combines analytical and preparative tasks in one instrument, to allow analytical-scale compound isolation through preparative-scale purification from a few milligrams to multiple grams of material. It has the unique capability to sample from any position of the fraction collector and allow purification and fraction reanalysis to be combined and homogenized before reinjections.

### Knauer Automated Quality Control of LC Columns

Knauer introduced a dedicated HPLC system capable of generating test certificates automatically for HPLC and fast protein LC (FPLC) columns at a column manufacturing facility.

**TABLE I:** New HPLC and MS instruments, chromatography data systems, and related products for 2019–2020

| Manufacturer | Product | Description |
|---|---|---|
| 908 Devices | Rebel | An integrated online MS analyzer for fresh and spent media analysis in the biopharma industry |
| ACD/Labs | ACD/method selection suite | New features include the generation of robust methods in silico and capability to predict the impact of method changes. |
| Agilent | 1290 Infinity II preparative open-bed sampler/collector | An extension to InfinityLab Purification Solutions to allow analytical-scale compound isolation to multiple grams of material |
| | InfinityLab LC companion | A mobile LC user interface to allow for remote control, monitoring, signal plotting, and diagnostics of Agilent 1260 and 1290 Infinity II LC systems |
| | InfinityLab LC–MSD iQ | A compact mass selective detector (MSD) for HPLC with auto data acquisition and maintenance to track instrumental health |
| | 6495C TQ LC–MS | Agilent's most sensitive triple-quadrupole MS system with easy maintenance to reduce downtime |
| | 6546 LC/Q-TOF | This quadrupole-time-of-flight MS system has an accelerated workflow with high resolution and wide dynamic range to deliver data for quick review. |
| Antec Scientific | Decade elite electrochemical detector (ECD) | This ECD is compatible with UHPLC and micro-LC systems for sensitive detection of neurotransmitters, carbohydrates, and pharmaceutical compounds. |
| ARC (Activated Research Company) | Solvere carbon selective detector | A universal detector using a flame ionization detector that converts of carbon to methane for HPLC and UHPLC applications. |
| Clarity | DataApex 8.2 | A new version of web-based and 21 *CFR* part 11 compliant CDS used by many smaller instrument manufacturers |
| Cornerstone Scientific | SolvFil disposable filter degassers | A disposable, polypropylene device with 90-mm membranes for filtering HPLC mobile phases directly into solvent reservoirs |
| Exum Instruments | Massbox | The Massbox couples TOF MS with solid sampling using laser ablation |
| IDEX | Film degasser | A flat film Teflon AF-based membrane online degasser for removal of dissolved air from typical HPLC mobile phases |
| Elga LabWater | PureLab Quest | The Quest is a water purification unit that produces Type I, II, and III water with a small footprint and low lifecycle costs. |
| Knauer | Automated quality control of LC columns | A dedicated HPLC system capable of generating test certificates for LC and FPLC columns at a column manufacturing facility. |
| Optimized Technologies | EXP2 All-in-One Ti-Lok | A hand-tight UHPLC fitting with integral ferrule capable of connections up to 18,000 psi |
| Pickering Laboratories | Onyx PCX | An optimized post-column derivatization system with pulseless dual-syringe reagent pumps for many regulated analyses |
| S-Matrix | Fusion QbD 9.9.0 | This new version offers features in PeakTracker with MS, an enhanced resolution response map, and support for forced degradation studies. |

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**TABLE I:** New HPLC and MS instruments, chromatography data systems, and related products for 2019–2020 (continued)

| Manufacturer | Product | Description |
|---|---|---|
| Sciex | Triple Q-TOF 6600+ system | A low-flow LC-MS instrument with ultrafast scanning acquisition and high-resolution data |
| Shimadzu | Nexera series LC-40 | The ultracompact system incorporates innovative features of many auto functions, mobile phase and maintenance monitoring, and remote user control and service diagnostics. |
| | Anion suppressor ion chromatograph (IC) | A compact 3000-psi PEEK-based IC system for quantitative analysis of anions |
| | LCMS-9030 Q-TOF | A new high-resolution Q-TOF MS system with a 3-m internal flight path that supports many ionization sources |
| | MALDImini-1 digital ion trap (DIT) MS. | This compact bench-top ion trap MS allows the user to check MS results right next to the sample preparation area. |
| Thermo Scientific | Vanquish Core HPLC | A new 700-bar HPLC system for routine analysis with features to enhance productivity, including fully automated solvent monitoring and integrated health checks |
| | Vanquish UHPLC online 2D-LC | Now supports two independent workflows and several standardized 2D-LC configurations |
| | An automated peptide mapping system | A smart digest automation system capable of reproducibility of ~3% |
| | Orbitrap Exploris 480 MS | Includes advanced capabilities, day-to-day reliability, and a compact footprint for high-throughput protein identification, quantitation, and structural characterization |
| | Orbitrap Eclipse Tribrid MS | Designed for a wide range of applications from small molecules to intact proteins for performing qualitative and quantitative analyses at low to high flow rates |
| | Chromeleon 7.3 CDS | This new version offers enhanced features for the laboratory and the information technology department. |
| Waters | Select series cyclic ion mobility separation (IMS) | This IMS combines acyclic flight path design and a TOF MS that supports resolution >100,000. |
| | Synapt XS | A tribrid (Q-IMS-TOF–MS) system with extended pathlength and improved sensitivity and flexibility. |
| Wyatt Technology | Dawn, miniDAWN and microDAWN multi-angle light scattering (MALS) systems | A new generation of MALS with updated optical, electrical, and mechanical components and enhanced interfacing for ease-of-use. |
| Young In Chromass (YL Instruments) | ChroZen UHPLC | A slimline UHPLC system with a binary pump (18,800 psi), equipped with UV-vis or PDA detector (2.4-µL flow cell), autosampler, and column oven (4 to 90 °C, three 15-cm columns |

### Shimadzu Nexera Series LC-40

Shimadzu Nexera Series LC-40 employs concepts of artificial intelligence (AI) and the internet of things (IoT) to incorporate innovative features such as auto-start, auto-purge, auto-shutdown, flow pilot, mobile phase and maintenance monitoring, multiplexing with dual injectors, and remote user control and service diagnostics. The ultracompact system consists of these modules: a system controller SCL-40, CBM-40; an absorbance detector, SPD-40 / SPD-40V; and a photodiode detector, SPD-M40; a solvent delivery unit LC-40 series (XS, XR or X3, with pressure rating of 80, 105, and 130 MPa respectively); an autosampler SIL-40 series/plate changer; and a column oven, CTO-40 series.

### Shimadzu Anion Suppressor Ion Chromatograph (IC)

Shimadzu's entry into the ion chromatography market is a compact and low-dispersion 3000-psi PEEK IC system designed for quantitative analysis of anions. It is controlled by the LabSolutions CDS with auto-shutdown, data processing, and report generation.

### Thermo Scientific Vanquish Core HPLC System

Thermo Scientific introduced the new 700-bar HPLC system to complement its family of Vanquish HPLC instruments (Flex, Duo, and Horizon with pressure ratings ranging from 1000 to 1500 bar). The Vanquish Core HPLC system targets routine analysis and quality control laboratories with a selection of quaternary, binary, dual-gradient, or isocratic pumps paired with a full line of detectors including UV-vis, diode array, fluorescence, charged aerosol, and MS detectors. The Vanquish Core HPLC system integrates SmartInject with additional intelligent features such as a fully automated solvent monitor and integrated automatic system health checks. Transitioning to this system from other HPLC systems is made simple with customizable injection programs, a fully tunable gradient delay volume, and enhanced method translation or transfer tools.

### Thermo Scientific Vanquish UHPLC Online 2D-LC

This customizable 2D-LC system supports two independent workflows and several standardized 2D-LC configurations. It can also function as two independent HPLC without manual replumbing.

### Thermo Scientific Automated Peptide Mapping

Thermo Scientific introduced an automated peptide mapping system capable of performing online digestion of a protein sample with reproducibility of ~3 %.

### Young In Chromass ChroZen UHPLC System

Young In Chromass (YL Instruments from Korea) introduced a slimline ChroZen UHPLC system with a binary pump (18,800 psi), equipped with UV-vis or photodiode array detector (2.4 µL flow cell), autosampler (injection volumes up to 10 µL), and column oven (4–90 °C which accommodates up to three 15-cm columns). It can be controlled by Clarity's DataApex CDS.

## HPLC Modules

### Antec Scientific Decade Elite Electrochemical Detector (ECD)

Antec Scientific introduced an electrochemical detector (ECD) that is compatible with UHPLC and micro-LC for the selective and sensitive detection of neurotransmitters, (poly)phenols, carbohydrates, and many pharmaceutical compounds. It is capable of a wide linear dynamic range of six orders of magnitude.

### ARC (Activated Research Company) Solvere Carbon Selective Detector

The Solvere carbon selective detector from Activated Research Company (ARC) is a universal detector using a flame ionization detector that converts compounds with carbon atoms to methane for HPLC or UHPLC applications. It is capable of a linear dynamic range of 5 orders of mag-

nitude from 10 ppm to 100% and allows an absolute calibration using a reference standard such as sucrose. The detector is compatible with most organic or volatile buffer mobile phases at flow rates of 0.3–0.5 mL/min. It is applicable to proteins, polymers, sugars, and other non-volatile carbon-containing analytes.

**Pickering Laboratories Onyx PCX**

Pickering Laboratories introduced a new optimized post-column derivatization system with pulseless dual-syringe reagent pumps for targeted analysis of amino acids, glyphosate, carbamates, toxins, antibiotics, and cannabinoids.

**Wyatt DAWN, miniDAWN, and microDAWN Multi-Angle Light Scattering Detectors (MALS)**

Wyatt Technology introduced a new generation of multi-angle light scattering (MALS) detectors designed with updated optical, electrical, and mechanical components and enhanced interfacing for ease-of-use.

DAWN is a size-exclusion-MALS detector for absolute molecular mass and size measurement of 200 Da to 1 GDa with 18 angles measurements and temperature control. This detector is indispensable for use with gel-permeation and size-exclusion chromatography to obtain reliable molecular mass distributions and information on molecular conformation, branching ratio, fragments, and aggregates.

MiniDAWN and microDAWN have a 200 Da to 10 MDa range with three angles of measurements that operate at ambient only. MicroDAWN is equipped with a microflow cell and is compatible with most UHPLC systems and an optional microOptilab refractive index detector. It uses an ultrastable laser with a sensitivity performance of 1.0 µg/mL of bovine serum albumin or 50 ng/mL 100 kDa polystyrene.

## Mass Spectrometers

The marketing landscape for mass spectrometry (MS) instruments has been described elsewhere (1). There is no slowing down of new MS introductions this year as manufacturers continued to upgrade their product offerings in high-resolution, hybrid, and tribrid MS—such as time-of-flight (TOF), quadrupole-TOF (Q-TOF), and orbital trap systems. Also, there are more offerings in compact MS instruments with unit resolution such as single-quadrupole (SQ), triple-quadrupole (TQ), and ion-mobility MS (IMS) (1,3). There are also newer startup companies focusing on unique application systems such as analyzers for fermentation media or solid sampling.

**908 Devices Rebel**

The Rebel from 908 Devices is an integrated online MS analyzer for fresh and spent media analysis in the biopharmaceutical industry. It is capable of a 7-min assay of 32 analytes (amino acids, bioamines, vitamins, dipeptides) with a 10-µL sample volume. The system is good manufacturing practices (GMP) compliant and can include automated sample preparation steps such as filtration and dilution.

**Agilent InfinityLab LC–MSD iQ**

One of three new MS systems introduced by Agilent Technologies in 2019–2020, the iQ is a compact single-quadrupole mass selective detector (MSD) for HPLC with auto data acquisition and reporting in auto-acquire mode, which automatically establishes optimal MS parameters with automatic tuning. The instrument can also help with maintenance tasks through its ability to track instrument health. It can be controlled by OpenLab CDS or a simpler open-access software. It is designed for small-molecule drug development and quality control, food and materials laboratories, and academic, chemical, or food industries. The iQ has a mass range of 2 to 1450 *m/z*, ~1 pg sensitivity, a maximum scan speed of 10,400 Da/s, unit resolution, and mass accuracy of 0.13 Da.

**Agilent 6495C TQ LC/MS**

The 6495C triple quadrupole (TQ) is a third-generation design as Agilent's most sensitive TQ-MS instrument with easy maintenance to reduce downtime. The system is ideally suited for peptide quantitation as well as applications that require part-per-trillion sensitivity. It has a mass range to 3,000 *m/z* allowing flexibility to handle any MRM transition.

**Agilent 6546 LC/Q-TOF**

This quadrupole time-of-flight (Q-TOF) MS instrument has an accelerated workflow with high mass resolution and wide dynamic range to deliver high-quality data for quick and simplified data review. With a mass resolution over 60,000 (for high masses) and over 30,000 (for low masses), sub-ppm mass accuracy, and isotope fidelity within 5%, it can provide quick answers for complex samples in metabolomics research, food safety, food authenticity, and environmental screening.

**Exum Instruments Massbox**

Exum introduced the new Massbox, which couples a TOF MS instrument with a mass range of 1000 to 14,000 with an innovative laser ablation ionization system for solid sampling.

**Shimadzu LCMS-9030 Q-TOF**

Shimadzu introduced a high-resolution Q-TOF MS system with a resolution up to 30,000 and a mass accuracy ~1 ppm. It has an internal 3-m flight path for better thermal stability and can maintain a mass accuracy of 1 ppm with calibration every 48 h. It is controlled by LabSolutions CDS and supports many ionization modes, including a dual source.

**Shimadzu MALDImini-1 Digital Ion Trap (DIT) MS**

The MALDImini-1 is a compact benchtop ion trap MS system that allows the user to check MS results right next to the sample preparation area. The system's digital ion trap uses rectangular wave radio frequency to enable ion trapping up to 70,000 Da. Furthermore, the MS/MS and $MS^3$ functionality of the DIT allows researchers to perform comprehensive structural analysis.

### Thermo Scientific Orbitrap Exploris 480

The new Orbitrap Exploris 480 is designed to ensure sound data with high-resolution accurate-mass (HRAM) selectivity (resolution up to 480,000), high scan speed (up to 40 Hz), and high mass spectral quality, all within a compact footprint. The standard mass range for the instrument is *m/z* 40–6000 and up to *m/z* 8000 with the BioPharma option.

### Thermo Scientific Orbitrap Eclipse Tribrid

This newest Orbitrap Tribrid MS platform includes advanced ion management technology (AIM+) with the new QR5 segmented quadrupole mass filter, real-time search, enhanced vacuum technology, optional proton transfer charge reduction (PTCR), and optional high mass range $MS^n$ ($HMR^n$) mode. Collectively, these features make this instrument uniquely suited for accurate and high-throughput full-proteome quantitation, characterization of complex mixtures of protein or small-molecule drugs, and deciphering higher-order protein structures.

### SCIEX Triple TOF 6600+ System

This TQ-TOF system supports low-flow applications with ultra-fast scanning acquisition and high-resolution MS data.

### Waters Select Series Cyclic Ion Mobility Separation (IMS)

This IMS system combines innovative design with a circular 98-cm flight path capable of multiple recycling, and a TOF-MS that supports resolution >100,000 for lipids, oligosaccharides, and other isobaric compounds.

### Waters Synapt XS

The Synapt XS is an extended platform of the Synapt line of MS, which a tribrid (Q-IMS-TOF-MS) system with an extended pathlength, improved sensitivity, and flexibility in supporting multiple ion sources and acquisition modes for solving challenging analytical problems.

## Chromatography Data System (CDS) and Software Products

The marketing landscape of chromatography data systems (CDS) has been described in an article published in *LCGC North America*'s December 2019 issue (4). The four leading chromatography manufacturers dominate the global CDS market with their current CDS product offerings of workstations and client-server systems (Waters Empower 3 feature release 5, Thermo Fisher Scientific Chromeleon 7.3, Agilent OpenLab versions 2.4, and Shimadzu LabSolutions version 5.3).

### ACD/Method Selection Suite

The new version of this software from ACD/Labs for HPLC method development offers improvements such as the generation of robust methods *in silico* and the capability of predicting the impact of method changes. The software is based on principles of quality by design (QbD) with multivariate analysis and can utilize databases of archived physicochemical properties.

### Agilent InfinityLab LC Companion

This software platform is a mobile LC user interface which allows for remote control, monitoring, signal plotting, and diagnostics of the Agilent 1260 and 1290 Infinity II LC systems. It resides on any mobile device (tablet or smartphone) using a compatible web browser.

### Clarity DataApex 8.2 CDS

Clarity introduced a new version of its web-based and 21 *CFR* Part 11 compliant CDS used by many instrument manufacturers. The CDS offers an improved user interfaces with many new instrument control drivers (up to 600), MS extension, compound search, and options for good laboratory practices (GLP) environments. It provides control and data handling for Advion MS and speciation analysis by PerkinElmer NexIon inductively coupled plasma–MS (ICP-MS) instruments.

### S-Matrix Fusion QbD 9.9.0

S-Matrix introduced a new version of its popular HPLC method development software based on the principles of QbD and design of experiments (DoE) as well as new features of PeakTracker (with Waters QDa SQ-MS), an enhanced resolution response map (vs. overlaid graph) for method robustness evaluation, and automation support for forced degradation studies.

**Thermo Fisher Scientific**
**Chromeleon 7.3 CDS**
Thermo Scientific introduced Chromeleon 7.3 CDS which offers enhanced features for both the laboratory (streamlined user interface with up to 33% higher performance, system health diagnostics for the new Vanquish Core HPLC system, superior auditing, review, query, and support, and improved e-workflow procedures), and the information technology (IT) department (scalable enterprise solutions for global and in-cloud deployment with improved data security and stability) (4).

## Other Accessories

**Cornerstone Scientific**
**SolvFil Disposable Filter Degassers**
A disposable, polypropylene device with 90-mm membranes for filtering HPLC mobile phases directly into solvent reservoirs.

**IDEX Film Degasser**
IDEX introduced a flat film Teflon AF-based membrane on-line degasser for removal of dissolved air from HPLC mobile phases. It is adaptable to any HPLC system up to 10 mL/min and has either 2 or 4 channels.

**Elga LabWater PureLab Quest**
Elga LabWater introduced PureLab Quest, a diverse water purification unit that can produce Type I (HPLC), II (reagent preparation), or III (rinsing) water with a small footprint and low lifecycle cost.

**Optimized Technologies**
**EXP2 All-in-One Ti-Lok**
The EXP2 is a hand-tight UHPLC fitting with an integral ferrule capable of connections up to 18,000 psi. It has a slim-fit nut and a wing nut for hand tightening.

## Summary and Commentary

Pittcon 2020 will be remembered as the chemistry conference which squeaked in just before more severe measures were taken in North America and Europe to combat the spread of the devastating coronavirus Covid-19. Less than a week later, the World Health Organization declared the spreading virus a global pandemic, and U.S. President Trump announced a state of national emergency for the United States. The country was in a semi-shutdown with travel bans, school closings, and indefinitely cancellation of all major public gatherings. The American Chemical Society (ACS) National Meeting in Philadelphia for late March was canceled, and the Analytica Conference in Munich was postponed from March to October. Still, Pittcon did suffer significantly from many cancellations of exhibitors and conferees, resulting in lower attendance and fewer exhibitors.

One disturbing trend unrelated to the coronavirus was the skipping of Pittcon this year by two major manufacturers (Waters and Thermo Fisher Scientific). Although Pittcon, as a premier event for new product introductions, has been declining in size in recent years as a result of competing conferences and other communication channels, it remains the largest general analytical chemistry conference in North America with global draws for buyers and sellers alike. It is my opinion that skipping Pittcon is a drastic and unpopular move in the eyes of many conferees who wish to compare new products on the exhibition floor. The opportunities to meet with friends and colleagues, learn new technologies, and see new instrumentation on the exhibition floor are what inspire many analytical chemists to come back to Pittcon year after year.

This installment summarizes new HPLC and MS products introduced at Pittcon 2020 and during the prior year and describes the pertinent features of these products. Personally, this is my 19th consecutive year of giving Pittcon HPLC short courses, which had a record attendance of 44 this year. My busy schedule included attending symposia, networking sessions, and the exhibition, interspersed with many meetings and social events, such as board or dinner meetings of *LCGC* and the Chinese American Chromatography Association (CACA), the Separation Community Mixer of the Chromatography Forum of the Delaware Valley, and the Pittcon Party at the Museum of Science and Technology.

In this unusual time of severe disruptions of conferences and travels, we are all hopeful that the world will survive the calamity and that our analytical chemistry community will return to some normalcy for Pittcon 2021 in New Orleans.

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