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Approaches to Lab Instrumentation Maintenance and Asset Management

Laboratory instrumentation is becoming increasingly sophisticated. With this sophistication, the maintenance and repair of instruments has become increasingly more crucial and complex, requiring the services of knowledgeable professionals. Equipment servicing is a growing source of revenues for both OEMs and third-party maintenance providers.

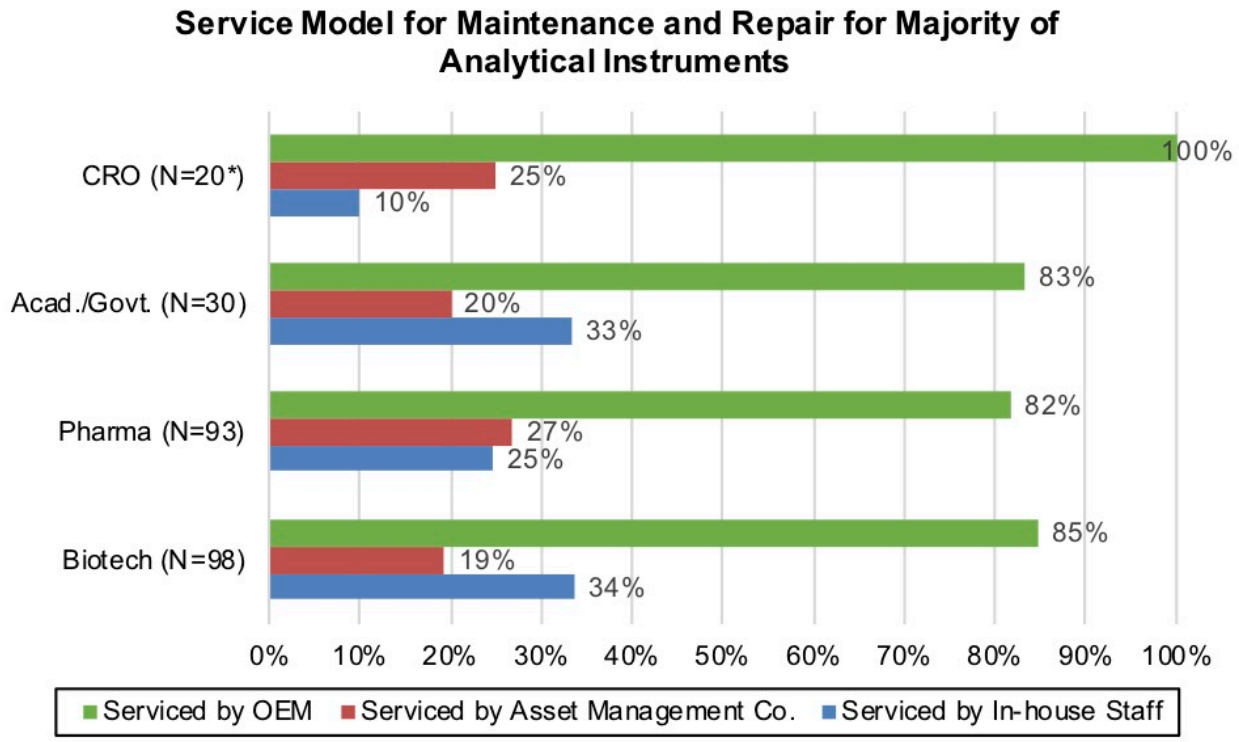
Users, on the other hand, must balance service costs and equipment downtimes which can potentially curtail productivity. To reduce potential downtimes, there has been a notable shift from reactive service (such as performing maintenance when something goes wrong) to proactive service (such as regularly scheduled maintenance and instrument-based preventative maintenance software).

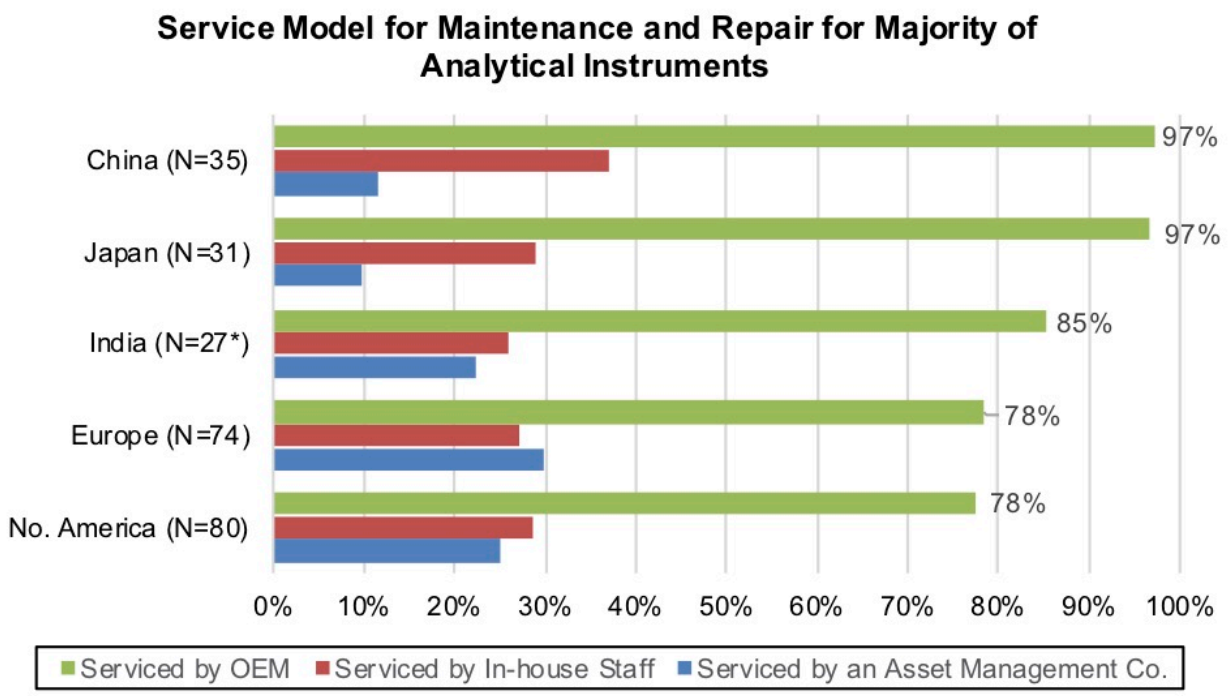
In general, there are three main models that organizations use for servicing equipment: they can rely upon the OEM to provide maintenance and repair, in-house staff with maintenance knowledge (either members of the research staff or a dedicated maintenance staff member) or they may contract with an asset management company. Asset management companies are generally third-party service providers that are capable of servicing multiple instrument brands. Offering service contracts and even on-site maintenance staff, these companies tout faster response times, shorter downtimes, and potentially lower costs than OEMs for instrument maintenance and repair. Asset management services are growing in popularity. Recognizing a growing opportunity, some well-known instrument companies that have traditionally been regarded as OEMs have established themselves as asset management providers, including Agilent Technologies, PerkinElmer and Thermo Fisher Scientific.

To gauge how maintenance needs of drug discovery labs are currently being addressed, 246 users of laboratory equipment were surveyed in October, for a report on analytical instrument use in drug discovery. This report, which will be available in late November from SDi, includes detailed market data, analysis and end-user perspectives for key technologies used in drug discovery and pre-clinical research. Given the primary topic of the survey, the majority of respondents were from the pharmaceutical and biotechnology industries.

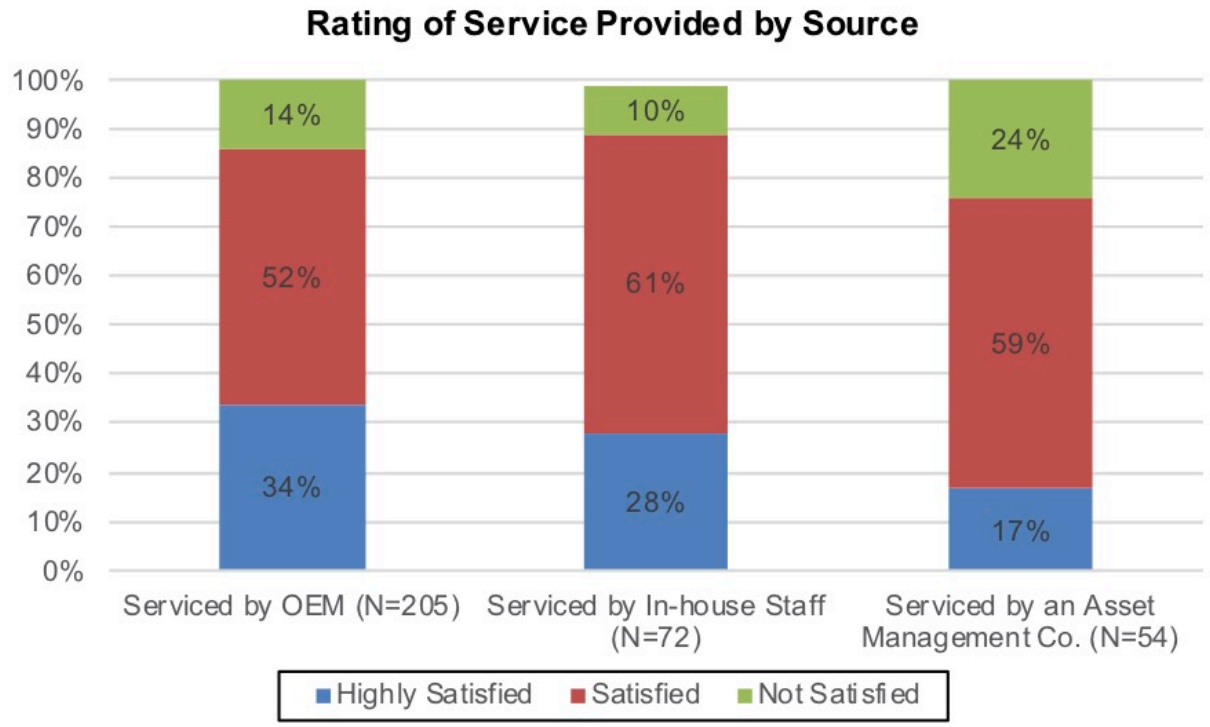
Respondents were asked which service model(s) for maintenance and repair their laboratories typically use for the majority of their analytical instruments. The vast majority, regardless of region or industry, reported that their instruments are most frequently serviced by the OEMs. But beyond

maintenance by OEMs, there were differences in servicing patterns for in-house staff and asset management companies. Users in the biotech industry and public sector (ie, academia and government) were more likely to rely on in-house staff for servicing, while users in the pharmaceutical industry and from CROs reported more frequently using asset management companies (see graph below). Regional differences were also apparent (see graph below). Users in Japan and China were the least likely to utilize asset management companies, likely due to less availability in these regions. In other areas, respondents utilized in-house staff and asset management companies at comparable levels.

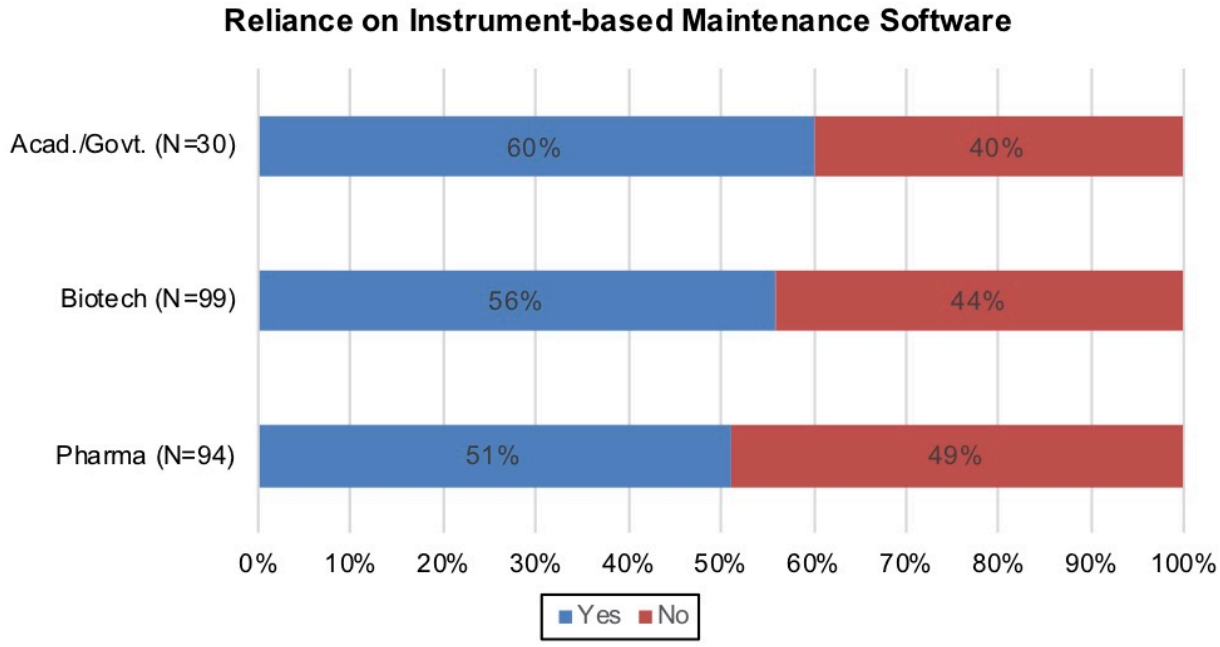


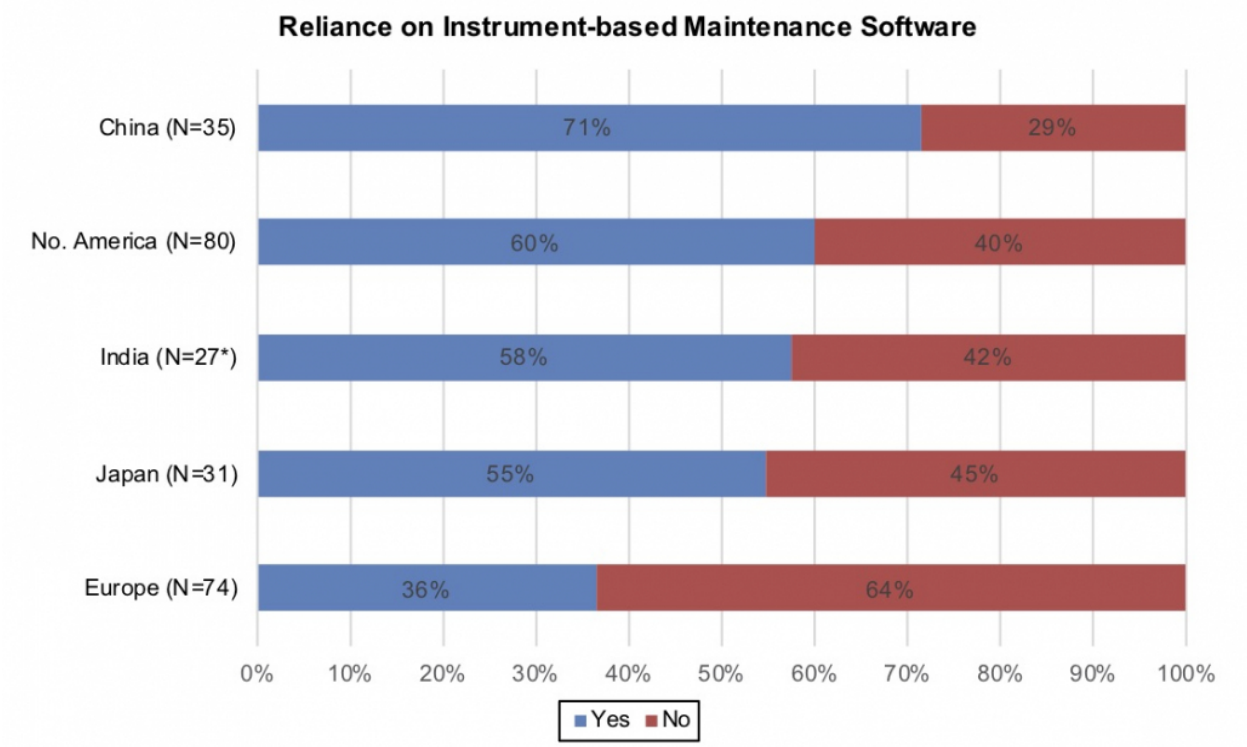


Respondents were asked to rate their satisfaction with the various service models that they use (see graph below). In general, respondents were satisfied with each service model. The highest-rated instrument maintenance model was provided by in-house staff, with 89% of respondents being highly satisfied or satisfied, and only 10% reporting being not satisfied. OEMs also received similarly favorable ratings, with 86% of survey respondents reporting favorable opinions. Seventy-six percent of respondents reported favorable opinions of service by asset management companies.



With the advancement of on-board software, many instrument manufacturers are including preventative maintenance software features that provide early warning for required service. Respondents were asked whether, for the majority of their analytical instruments, they rely on these features. Responses were influenced by whether users had instruments with this software available. Fifty-five percent of respondents reported relying on instrument-based preventative maintenance software. At 60%, respondents from academia and government were the most likely to rely on the software, while pharmaceutical industry users, at 51%, were the least likely (see graph below). Interestingly, there were very pronounced regional differences in how reliant users were on the software (see graph below) as 71% of respondents in China reported relying on preventative maintenance software, in contrast to only 30% of European respondents.



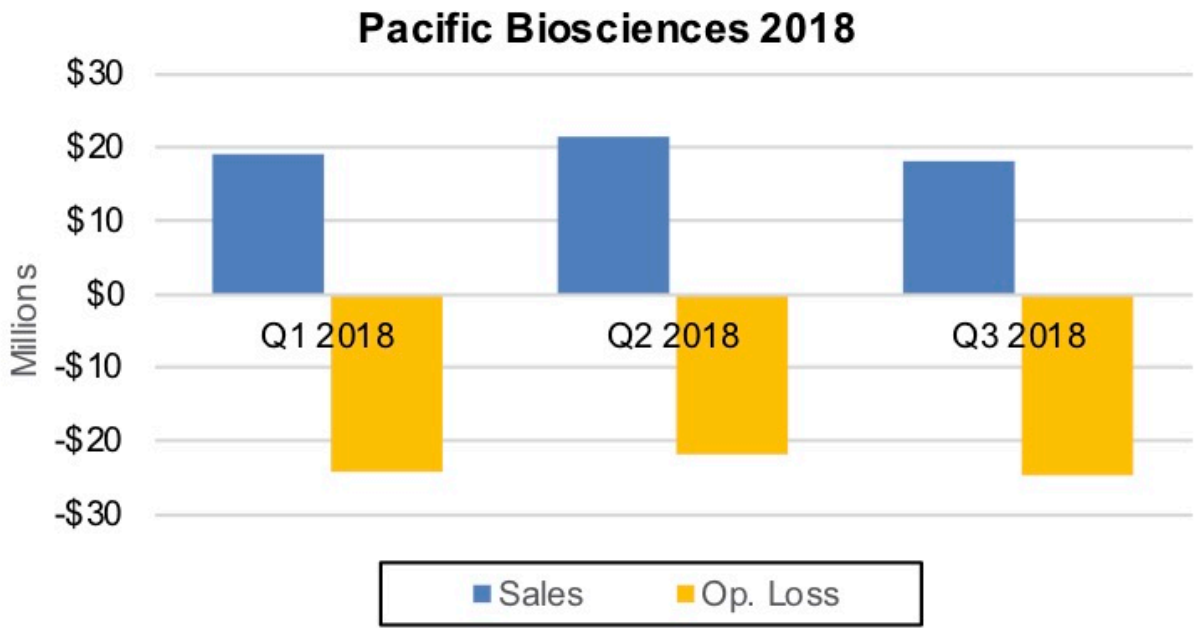


As instruments become more technically complex and automation more commonplace, users will grow more reliant upon outsourced professional maintenance services. Maintenance, whether reactive or proactive, is a fundamental part of laboratory operations.

The Long and the Short of It: Illumina to Buy Pacific Biosciences

Aiming to fortify and build upon its dominance of the sequencer market, Illumina announced this month an agreement to acquire Pacific Biosciences (PacBio) (see Executive Briefing). The acquisition will bring together the largest short-read and largest long-read sequencing companies, respectively, bridging a divide that has characterized the post-Sanger sequencing market since its inception.

Illumina values the all-stock purchase at approximately $1.2 billion. In 2017, PacBio recorded sales of $93.5 million but a net loss of $92.2 million (see ***IBO*** 2/15/18). For the nine month period ending September 30, revenue dropped 13.8% to $59.1 million. The company had warned of slower sales due to an impending product update. Nine month net loss was nearly even with a year ago at $71.8 million.



Illumina asserts the acquisition enables it to offer sequencing systems for new applications and a wider range of researchers and labs, as well as those wanting both short- and long-read sequencing. Both companies offer sequencing by synthesis technologies, but while Illumina sequencers produce segments of DNA up to 600 bp in length, PacBio's long-read technology produces DNA segments

up to 20 kb. Short-read has generally been preferred for most applications due to its cost, speed and accuracy. In contrast, PacBio's SMRT technology can characterize structural variants, repeat regions and DNA modification.

A New Era?

As Illumina stated in its conference call discussing the deal, being able to offer its customers both technologies will be a competitive advantage. "Over time, we will provide more seamless integration of the workflows and analytical pipelines to allow customers easier access to the combined power of the two technologies," stated President and CEO Francis deSouza. "We expect that together these benefits will allow broader market access, enabling faster growth. Together, we will provide more researchers, more physicians, more patients and more consumers a more perfect view of a genome."

Although PacBio had mainly made inroads into the NGS market with de novo sequencing of plants and animals, its latest product introductions are expected to make the company's SMRT sequencing technology as affordable and accurate as Illumina's short-read sequencing (see ***IBO*** 10/31/18), opening up new applications in human genomics, including drug development and clinical applications—a change that Illumina recognized. "With this level of accuracy, researchers will be able to create complete genome assemblies at Q50 consensus quality to comprehensively and accurately detect all classes of variance. Importantly, PacBio's improved workflow will obviate the need for large quantities of high molecular-weight DNA, which hinders other long-read technologies," said Mr. deSouza. The other widely commercialized long-read technology is Oxford Nanopore Technologies' nanopore sequencing systems, which has reported read lengths of more than 1 Mb with its systems.

In its first quarter call, PacBio disclosed an installed base of around 400 systems. This compares with Illumina's installed base of more than 11,000 systems. Consequently, Illumina expects to use its more extensive resources to grow PacBio. "[W]e have experience with global operations and manufacturing and distribution and support. And so we think that the combination strengthens the roadmap that PacBio has and strengthens the go-to-market motion around the offerings that they're bringing to market next year," noted Mr. deSouza.

Clinical Opportunities?

Clinical sequencing is the fastest growing segment of the sequencing market. Illumina discussed the existing and possible applications of the PacBio technology in clinical markets, as well as new opportunities made possible by PacBio's latest technology upgrades. Mr. deSouza commented, "[T]he power to improve structural variant and CNV [copy number variation] analysis enables improved studies and potentially accelerates discovery in areas like rare and undiagnosed diseases, oncology and clinical microbiology that often involves phased genomes without access to a reference."

As PacBio President and CEO Michael Hunkapiller told investors this spring on the company's first quarter earnings call, "Our ongoing goal is to enable our customers to generate up to 150 Gb of data from a single SMRT cell, which would then enable us to provide high-quality human-size de novo genomes for approximately $1,000 and low-coverage genomes for structural variant analysis for substantially less."

PacBio's recent forays into the clinical market included HLA typing, for example, a partnership with GenDx (see ***IBO*** 8/15/14); newborn sequencing as part of collaboration with Mount Sinai (see ***IBO*** 7/15/11); and precision medicine through an agreement with Novogene. On recent earnings call, the company has discussed research results from clinical studies at HudsonAlpha, rare disease research at Radboud University Medical Center in the Netherlands and work with the American Association for Cancer Research using its Iso-Seq method for sequencing of full-length RNA transcripts.

The Future?

The acquisition will put Illumina in a unique position as none of the company's existing sequencer competitors either in the short-read market, BGI, QIAGEN and Thermo Fisher Scientific, or long-read market, Oxford Nanopore, can offer both short- and long-read technologies. However, NanoString Technologies' Hyb & Seq technology, which is scheduled to commercially launch in 2020, promises simultaneous short and long reads, and like PacBio's technology, hybridization sequencing is an amplification-free, single molecule sequencing technique. The company also touts the technology provides parallel sequencing of RNA and DNA and a significantly shorter sample preparation

workflow than existing short-read technologies. NanoString has stated that it expects to target the clinical sequencing market.

Addressing anti-trust concerns, Mr. deSouza said on the call, "[W]e serve the short-read market in sequencing. And the segments we serve are complementary to the segments that are served by the long-read players, in the sense that we are uniquely qualified for the segments that we play in, and we have a set of competitors in our short-read segment. And frankly, we don't really play in some of the long-read segments at all."

But other sequencer companies appear to be focused on either short- or long-read lengths techniques. Agilent Technologies is expected to extend its clinical NGS workflow targeting the routine clinical market with the introduction of a sequencing system, scheduled for release in 2020. In addition, Direct Genomics recently unveiled a short-read sequencing system for the clinical market.

On the long-read side, additional nanopore technologies are moving toward commercialization. Roche acquired nanopore sequencer developer Genia Technologies in 2014 (see ***IBO*** *6/15/14*) and has invested in Stratos Genomics for nanopore chemistry (see ***IBO*** 8/15/16). Roche dissolved its partnership with PacBio for clinical systems in 2016 (see ***IBO*** 12/15/16). Other nanopore instrument developers include Beijing Meili Technology and Quantapore.

Illumina's planned purchase of PacBio, and investments in these nanopore firms, only serve to further illustrate the value of long-read sequencing and the further progress of sequencing technology.

Society for Neuroscience 2018: New Products Accommodate Larger Animals

The 48th annual Society for Neuroscience Conference took place November 3–7 in San Diego, California. Attendance was 28,691, including 22,726 scientific participants. A total of 539 companies exhibited.

While most exhibitors were associated with neuroscience tools, such as fluorescence and confocal microscopy or antibodies, a number of life science companies also had booths, reflecting the prevalence of cell research and even genomics in neuroscience. Such companies included 10x Genomics, Bio-Rad Laboratories and Illumina.

All major confocal microscopy companies had large booths at the show, as well as companies expanding their presence in emerging market segments, such as super-resolution microscopy and

optogenetics. Among the companies exhibiting that are expanding their super-resolution offering through acquisitions were Bruker (see ***IBO*** 5/15/17) and Miltenyi Biotec (see ***IBO*** 10/31/18).

In fact, Bruker launched two new systems at the show. A result of its purchase of Luxendo Bioscience, the new Luxendo MuVi SPIM CS light-sheet fluorescence microscope expands the Luxendo MuVi SPIM product line with the ability to image clear tissues in 3D. A modular system, the same instrument can be used to image living samples and cleared tissue samples. Other new features are improved optics, including two Nikon 10x 0.3 NA air objective lenses, and a choice larger sample chambers, including one that can accommodate a whole mouse brain.

Bruker's new Ultima 2Pplus wide-field, multiphoton microscope replaces the Ultima 2P, initially introduced 15 years ago. The new system features enhanced detection for a larger field of view. Capable of 1-photon imaging of up to 500 µm depths and 2-photon imaging down to 1 mm, the system is also future-proofed for 3-photon imaging. As Bruker explained, laser manufacturers are currently developing laser technology to enable turnkey 3-photon systems.

Also, with a focus on accommodating larger animal models, such as mice and hamsters, Leica Microsystems displayed the SP8 DIVEB (Deep In Vivo Explorer) for multicolor, multiphoton imaging, a new iteration of the SP8 DIVE system featuring a larger sample chamber. The new systems enable behavioral studies. Leica Microsystem's product launches also included the Thunder imagers for wide field imaging, specifically designed for improved resolution of thick specimens. The platform works by removing autofocus light so that only the desired signal is acquired. Applications include 3D cell culture and 3D live cells, tissues and model organisms.

The role of software for high-resolution microscopy was evident from ZEISS' recently announced expansion of its partnership with arivis. arivis provides software platforms for life sciences in the form of dedicated and proprietary software modules and bundled products. The partnership with ZEISS includes further cooperation in 3D/4D image visualization and analysis. As arivis, which was represented at ZEISS' booth, told ***IBO***, its platform's processing power is not limited by the size of the data file due to the image core technology. Automatic file conversion is possible while the microscope is still recording large 4D images. arivis software recognizes, classifies and segments data, allowing processing of specific sample areas or the complete data set even on affordable computer systems.

This month, ZEISS announced the integration of its Airyscan confocal imaging microscope with Inscopix's miniature microscope system. The ability to integrate Airyscan's coregistration of subcellular and structural details with Inscopix's functional neural network activity provides insights into brain function and dysfunction.

At the show, Inscopix exhibited its miniature microscope platform, specifically designed to study large-scale brain activity at cellular resolution in freely moving animals. More than 50 scientific presentations using Inscopix technology were showcased at the SfN meeting. By mounting the microscope on a mouse's head, brain cell activity is imaged directly through a lens implanted in the brain and can record hundreds to thousands of cells at a time. Inscopix told ***IBO*** that the system allows researchers to ask new questions about the function of brain circuits involved in specific behaviors, such as motor planning and cognition.

Although companies known for general lab equipment were not as prevalent at the show, Eppendorf and Sartorius each exhibited. Eppendorf displayed its new CellXpert C170i CO2 incubator. The system, along with the more basic C170 model, is the company's first new incubator since the Galaxy CO2 incubators from New Brunswick Scientific, which Eppendorf acquired in 2007, and is the first such product carrying the Eppendorf brand.The system includes onboard data and event logging, facilitating regulatory compliance. Other field-upgradable options include the ability to change the door handle to the opposite side and optional humidity and water-level sensors. The Cell Xpert also connects to Eppendorf's VisionNize system, which is designed for centralized monitoring of multiple Eppendorf products. The list price is $9,085.

BioTechne also exhibited at the show, displaying Jess, its latest automated Western blot system, introduced this summer. In contrast to the company's Wes instrument, Jess expands beyond chemiluminescence detection to include NIR and IR detection, keeping high sensitivity for multichannel, multiplexed analyses. Multiple detection modes can replace the use of two instruments as well as serve users in the same lab with different requirements. An example of the multiplexing capabilities include the measurement of multiple targets simultaneously in one lane instead of two lanes to compare band intensities and protein isoforms. Results are available in 3 hours, or 4 hours for protein normalization.

Next year's SfN conference will be held October 19–23 in Chicago, Illinois.

Illumina to Buy Rival for Over $1 Billion

San Diego & Menlo Park, CA 11/1/18—Sequencer firm Illumina has agreed to acquire Pacific Biosciences for $8 per share, or approximately $1.2 billion. The price represents a 71% premium to Pacific Biosciences' 30-day volume–weighted average share price. Pacific Biosciences offers a long-read sequencing technology. "PacBio's unmatched accuracy mirrors that of Illumina's in short-read sequencing. Combining the two technologies positions us to reach more applications, accelerate the

pace of genomic discovery and bolster our innovation engine which has been a hallmark of Illumina since our inception," stated Illumina President and CEO Francis deSouza. "PacBio's relentless pursuit to improve sequencing accuracy, while driving down the cost, underscores the potential of long reads to expand sequencing to new customers and applications." The transaction is expected to close in mid-2019. (For Pacific Biosciences' latest quarterly results, see Third Quarter Results: Danaher, Illumina, Pacific Biosciences, PerkinElmer, Thermo Fisher Scientific and Waters.)

The purchase could be a game changer for long-read technology adoption as Illumina plans to invest in product development and sales. Illumina can also now address shortcomings of its existing technology, particularly for analyzing large and complex regions of the genome. For more on the announcement, see "The Long and the Short of It: Illumina to Buy Pacific Biosciences."

Twist Bioscience Completes IPO

San Francisco, CA 10/31/18; Washington, DC 11/1/18—Twist Bioscience, developer of a platform for producing synthetic DNA, has completed the public offering of its stock for $14 per share (see ***IBO** 10/31/18*). The company reported estimated proceeds, before expenses, of $65.1 million. The company also granted a 30-day option for underwriters to purchase an additional 750,000 shares. The company estimates total proceeds, including the underwriter's option fully exercised and expenses, to be $71.4 million.

The price was at the low end of the company's estimates of $14–$16 per share. MarketWatch estimates the company's market cap at $372.5 million. Directors and executives are expected to own 31% of outstanding capital shares following the offering. By function, the proceeds will be used for: technology and facilities investments ($15–$20 million); sales and marketing ($15–$18 million); expansion of the business into biologics drug discovery and DNA data storage ($12–$14 million); establishment of operations in China ($5–$10 million); and working capital and general corporate purposes.

FOSS Buys Software Provider

Silkeborg & Hillerød 11/6/18—FOSS, which provides analytical solutions for food and agriculture producers, has acquired a 51% stake in Au2mate for an undisclosed amount. Based in Denmark with around one hundred employees, Au2mate is a developer of process automation and industrial IT and system integration, particularly for dairy companies. "Getting closer to that expertise will allow us–on a much larger scale–to connect the FOSS instrument and its data to the overall operational setup at the production facility," commented FOSS CFO Kenneth Aaby Sachse. Au2mate CEO

Carsten G. Jensen and Business Development Director Klaus Dam will remain with the company, which will operate as a separate business.

Au2mate provides process automation control platforms for the food and chemical industries. FOSS' existing process instrumentation include the MilkoStream FT system for in-line FTIR testing and NIRS DS2500 Flour Analyzer. Several other system are designed for in-field and production-area use.

PerkinElmer Sells Phenoptics Business

Menlo Park, CA 10/31/18—Akoya Biosciences, a provider of solutions for tissue phenotyping, has acquired PerkinElmer's Phenoptics portfolio, consisting of the Mantra, Vectra and Vectra Polaris multiplex immunofluorescence systems. Akoya provides the CODEX tissue analysis system. "With both the Phenoptics portfolio and CODEX, Akoya will provide our customers with a full suite of end-to-end solutions for high-parameter tissue analysis," commented Akoya CEO Brian McKelligon." Akoya Bioscience's CODEX systems are designed for multiparameter tissue analysis. Terry Lo, general manager of the Phenoptics team, will serve as president of Akoya.

PerkinElmer stated in its third quarter earnings call that the sale price was $37 million and that the business had nine month revenues of $23 million. The divestment is not expected to impact 2018 adjusted EPS. Both the acquired and legacy Akoya Biosciences products address the pathology research market, providing multiplexed alternatives to traditional immunohistochemistry. PerkinElmer launched the Mantra system in 2014, the first of the three divested systems, as part of a workflow that also included assays, reagents, software and contract research services.

Bruker Invests in Optical Metrology

Billerica, MA 11/14/18—Scientific instrument firm Bruker has acquired Austria-based Alicona Imaging from Quadriga Capital for an undisclosed amount. Alicona Imaging supplies optical 3D metrology products, complimenting Bruker's microCT, stylus profiler, white light interferometry and AFM product lines. "Alicona has led the industry in the development of focus variation technology and has delivered high-quality metrology products and manufacturing QA/QC solutions to the market that align nicely with our own products and our strengths in industrial metrology," commented Bruker NANO Group President Dr. Mark R. Munch. Alicona Biosciences has 150 employees.

Alicona' offerings focus on form and roughness. Markets served by the company include additive manufacturing, medical technology, and the pharmaceutics and automotive industries. Bruker entered the

optical metrology market with its 2010 acquistion of Veeco Instruments' SPM and Optical Industrial Metrology businesses (see **IBO** *8/31/10).*

Bio-Rad Declares Victory in 10x Suit

Hercules, CA 11/14/18—Bio-Rad Laboratories, a provider of products for the life science research and clinical diagnostic markets, has announced that a District Court jury has ruled in its favor in a patent infringement suit against 10x Genomics. The patents are held by the University of Chicago and exclusively licensed to Bio-Rad. The jury awarded Bio-Rad $23.9 million in damages, finding that 10x's Single Cell and Linked-Read genomics products willfully infringed. "BioRad remains committed to growing and protecting its portfolio of patents in the droplet microfluidics space and to delivering differentiated genomics technologies that enable world class research," stated Bio-Rad President and CEO Norman Schwartz.

The 2015 suit (see **IBO** *4/30/15) involved US Patent Nos. 8.889,083 (Device and Method for Pressure-driven Plug Transport and Reaction), 8,304,193 (Method for Conducting an Autocatalytic Reaction in Plugs in a Microfluidic System) and 8,329,407 (Method for Conducting Reactions Involving Biological Molecules in Plugs in a Microfluidic System). The original plaintiff was RainDance Technologies, which Bio-Rad later acquired (see* **IBO** *1/31/17).*

The companies also have two other cases pending in District Court (see **IBO** *11/15/17 and* **IBO** *5/31/18) as well as interpartes review proceeding at the US Trade and Patent Office. Last month, Bio-Rad Laboratories filed another suit against 10x Genomics alleging infringement of US Patent Nos. 9,562,837 (Systems for Handling Microfluidic Droplets) and 9,896,722 (System For Handling Microfluidic Droplets), which were also RainDance Technologies' patents, by 10x's Chromium and GemCode systems and reagents.*

Third Quarter Results: Danaher, Illumina, Pacific Biosciences, PerkinElmer, Thermo Fisher Scientific and Waters

Danaher Environmental and Applied Solutions Segment Gets Boost from China

Selected Danaher Segments Q3 FY18					
	Rev. (M)	Chg.	Currency	Acq./Div.	Organic Chg.
Life Sciences	$1,596.7	14.7%	1.5%	-6.5%	9.5%
Environmental & Applied Solutions	$1,074.4	8.2%	1.5%	-1.5%	8.0%

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Danaher's 7.0% revenue growth with core growth of 6.5%, for the third quarter, was led in part by 14.5% revenue growth for the Life Sciences business (see ***IBO*** 10/31/18). Recurring revenue represented 65% of Life Science sales. Environmental and Applied Solutions revenue increased by 8.2%, with recurring revenue representing 53%.

Selected Danaher Segments Q3 FY18			
	Op. Margin	Chg. (bps)	Core Chg. (bps)
Life Sciences	19.6%	190	230
Environmental & Applied Solutions	23.7%	130	160

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Within the Life Sciences segment, Beckman Life Sciences revenue rose high single digits due to growth across all major product lines and geographical areas, with notable growth in the biologics and genomics markets. SCIEX revenue grew high single digits due to the sales of the X500 MS platform, as well as growth in North America and China.

Also, within the Life Science segment, Leica Microsystems revenue was up high single digits, and Pall increased in the double digits. In addition, the recently acquired Integrated DNA Technologies (see ***IBO*** 03/15/18) produced mid-double digit revenue growth.

Selected Danaher Segments Q3 FY18				
	Life Science		Envrionmental & Applied Solutions	
	Rev. (M)	% of Seg. Rev.	Rev. (M)	% of Seg. Rev.
North America	$584.0	37%	$439.7	41%
Western Europe	$447.1	28%	$257.5	24%
Other	$134.5	8%	$31.0	3%
High Growth Markets	$431.1	27%	$346.2	32%

Within the Environmental and Applied Solutions segment, water quality sales grew double digits, including double-digit revenue growth for Hach. The company's revenue growth was attributed to China's prioritization of water quality, which drove sales 30.0% in the region. Danaher forecasted fourth quarter revenue to increase approximately 4%.

Illumina Strong Sequencing Consumables Leads Revenue Growth

Illumina Q3 FY18			
	Chg.	Rev. (M)	% of Rev.
Consumables	22.0%	$550	64%
Instrument	10.0%	$154	18%
Other Products	20.0%	$6	1%
Service & Other	21.2%	$143	15%

Illumina third quarter revenues grew 20% and were led by growth in sequencing and an increase in microarray sales, respectively (see Bottom Line.).

Illumina Q3 FY18		
	Rev. Chg. Sequencing	Rev. Chg. Microarrays
Consumables	22.9%	16.9%
Instruments	7.8%	33.3%
Other Products	0%	NM
Services and Other	36%	-10.5%

Sales of sequencing consumables grew 23%, which included $14 million worth of orders from Chinese customers buying ahead of potential tariffs. Major contributors to this growth included the demand of consumables for the high-throughput sequencer NovaSeq, the adoption of consumables for the mid-throughput sequencer NextSeq for NIPT and oncology applications, and respectable sales of low-throughput consumables for both the MiSeq and MiniSeq sequencers. Overall, sequencing consumables represented 55% of total revenues for the quarter.

Illumina Q3 FY18			
Adj. Op. Profit (M)	**Chg.**	**Adj. Op. Margin**	**Chg. (bps)**
$251	30.7%	29.4%	253.48

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Sequencing systems sales were up, making it the highest revenue quarter since the fourth quarter of 2015. For the remainder of the year, the company still expects to ship 330–350 NovaSeqs systems, thanks to consistent pricing and the product's upgrade cycle. Low-throughput systems, MiSeq and MiniSeq, were adopted by both new and existing customers across all regions and represented 50% of shipments in the third quarter.

Illumina Q3 FY18		
	Rev. Chg.	**% of Rev.**
US	13.7%	56%
Europe	32.7%	26%
Greater China	17.2%	12%
Asia Pacific	28.9%	7%

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Geographically, the US, Europe and Greater China all experienced double-digit growth. Specifically, the APJ had its strongest quarterly revenue since early 2014. Illumina declared its fourth quarter revenue guidance to be flat or slightly up sequentially because of expected declines of sequencing

consumables, after $20 million of consumable revenue was shipped to Greater China in the second and third quarters.

Low Consumables Sales Slow Down Pacific Biosciences Revenue Growth

Pacific Biosciences Q3 FY18			
	Rev. (M)	Chg.	% of Rev.
Total Company	$18.2	-22.9%	
Product	$15.2	-25.5%	83%
Instrument	$6.3	-35.2%	
Consumables	$8.9	-16.7%	
Service and Other	$3.0	-6.0%	17%

Third quarter revenue for Pacific Biosciences decreased 22.9% to $18.2 million due to lower instrument shipments and consumable sales (see Bottom Line). Lower consumables sales were attributed to the decreased demand of RS II consumables and an uneven customer ordering pattern. Though consumables sales were low, installed Sequel instruments increased. The company claimed that customer orders slowed because of anticipation of recently launched or announced products for early next year. Pacific Biosciences did not provide a forecast for the fourth quarter or the full year.

Pacific Biosciences Q3 FY18			
	Rev. (M)	Chg.	% of Rev.
North America	$9.0	-1.7%	49%
Europe	$2.9	-8.9%	16%
Asia Pacific	$6.3	-44.0%	35%

Pacific Biosciences Q3 2018			
Op. Profit (M)	Chg.	Op. Margin	Chg. (bps)
-$24.7	-12.0%	-135.8%	-4232

PerkinElmer Reports Strong Organic Growth Thanks to Diagnostic Division

PerkinElmer Q3 FY18						
	Rev. (M)	% of Rev.	Chg.	Currency	Acq./ Div.	Org. Growth
Total Company	$674.3		21.7%	-2%	16%	7%
Discovery & Analytical Solutions	$406.2	60%	5.4%	2%	0%	7%
Diagnostics	$268.1	40%	58.8%	3%	53%	8%

PerkinElmer's third quarter sales grew high single digits organically for the company as well as for each of its two divisions Product and Service revenues rose 33.7% and 0.17% to make up 70% and 30% of sales, respectively (see Bottom Line). All figures below are given on an organic basis.

PerkinElmer Q3 FY18				
	Adj. Op. Profit (M)	Chg.	Adj. Op. Margin	Chg. (bps)
Total Company	$128.6	22.1%	7.0%	178
Discovery & Analytical Solutions	$48.4	2.3%	11.9%	114
Diagnostics	$47.4	9.2%	17.7%	-104

Geographically, all major areas saw revenue growth with double-digit sales in Asia, high single-digit sales in the Americas and low single-digit sales in Europe. China and India both recorded double-digit sales. Europe was the weakest region due to soft sales in applied markets, specifically the industrial segment for which they decreased by 3%. Also, Europe experienced summer droughts, which led its sales in the food analysis segment to decrease significantly.

PerkinElmer Q3 FY18				
	Discovery & Analytical Solutions		Diagnostics	
	Rev. (M)	% of Sales	Rev. (M)	% of Sales
Americas	$169.4	41.7%	$95.6	35.7%
Europe	$110.7	27.3%	$68.5	25.5%
Asia	$126.1	31.0%	$104.1	38.8%

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Discovery & Analytical Solutions (DAS) sales were led by high single digits in life sciences and mid-single digits growth in applied markets. Life sciences, which represented 35% of the company's overall revenue, was driven by high demand in the pharmaceutical and biotech end-markets. Specifically, strong sales in the spectroscopy and chromatography product lines were factors for DAS' overall revenue growth. In addition, PerkinElmer's vivo imaging products were a key element for revenue growth for the DAS division.

Revenue growth for applied markets was led by PerkinElmer's sales in spectroscopy and LC/MS, as well as Perten sales. Overall, the company's food analysis segment experienced a 10% increase. Combined, the environmental and industrial segments delivered solid revenue growth of 6%. Geographically, the applied markets experienced high demand in Asia and the Americas.

PerkinElmer Q3 FY18		
Endmarket	Discovery & Analytical Solutions	Diagnostics
Diagnostics	—	$268.1
Life Sciences	$222.2	—
Applied Markets	$184.0	—

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In the Diagnostic division, sales were led by double-digit growth for the immunodiagnostics and applied genomics businesses. Strong sales for Tulip Diagnostics and Haoyuan Biotech contributed to the immunodiagnostics segment's high-teens revenue growth. Applied genomics' robust sales were attributed to the segment's front-end sample preparation systems.

Since being acquired late last year (see ***IBO*** 06/30/17), EUROIMMUN's performance has shown consistent sales growth with an increase of 11% this quarter. The subsidiary's autoimmune modalities made up approximately 60% of its sales and accounted for 16% of its revenue growth. In addition, the combined sales of infectious disease, allergy and instrument sales for antigen detection spurred double-digit revenue growth. Geographically, EUROIMMUN recorded robust sales in China and Germany. PerkinElmer forecasted EUROIMMUN's fourth quarter revenue to increase 15%.

The company raised its full-year revenue growth guidance from 6% to 6.5%. Fourth quarter sales are forecasted to rise 5% organically or 16% including acquisitions.

Life Sciences Solutions Leads Broad-based Growth for Thermo Fisher Scientific

Reported double-digit third quarter revenue growth for Thermo Fisher Scientific included 7% growth from acquisitions and a 1% decrease from currency. (See ***IBO*** 10/31/18.) The company reported broad-based growth, including strength in all four business segments.

Thermo Fisher Scientific Q3 FY18				
	Rev. (M)	**Chg.**	**% of Total Rev.**	**% Organic Chg.**
Total Company	$5,920	15.7%		10%
Life Science Solutions	$1,504	8.8%	24%	10%
Analytical Instruments	$1,333	12.1%	21%	12%
Speciality Diagnostics	$894	5.9%	14%	7%
Laboratory Products & Services	$2,470	27.8%	40%	11%

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Revenue growth in the Life Sciences Solutions segment was led by bioproduction, biosciences and clinical NGS. The Specialty Diagnostics segment was driven by the health care market, and transplant and clinical diagnostics business, while the Laboratory Products and Services saw strong growth in the clinical trial logistics business, and research and safety market.

Thermo Fisher Scientific Q3 FY18				
	Adj. Op. Profit (M)	Chg.	Adj. Op. Margin	Chg. (bps)
Total Company	$1,311	12.1%	22.1%	-14
Life Sciences Solutions	$495	9.5%	32.9%	138
Analytical Instruments	$294	14.4%	22.1%	230
Specialty Diagnostics	$223	2.3%	24.9%	0
Laboratory Products & Services	$299	23.0%	12.1%	-46

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Sales to the biotech and pharmaceutical end-markets increased in the high teens, while sales to the industrial and applied end-markets delivered high single digits growth due to strong sales for the Analytical Instruments business. Sales to the academic and government end-market as well as diagnostics and healthcare both grew mid-single digits.

Thermo Fisher Scientific Q3 FY18		
	Rev (M)	% of Total Rev.
North America	$3,030	51%
Europe	$1,454	25%
Asia-Pacific	$1,251	21%
Other	$185	3%

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North America, Europe and Rest of World led regional growth, with sales for each increasing in high-single digits. Asia-Pacific sales rose in the low teens. Within Asia-Pacific sales, Chinese sales rose more than 20% to $629 million. Within North America, US sales grew 19% to $2.9 billion.

Thermo Fisher Scientific Q3 FY18		
	Rev (M)	% of Total Rev.
Consumables	$3,056	52%
Instruments	$1,515	26%
Services	$1,349	23%

The company narrowed its full-year revenue guidance to 15% growth, including 7% organic growth. The company attributed the increase to strong operational performance, offset by a 1% tailwind from currency.

Soft TA Instrument Product Sales Impact Waters

Waters Q3 FY18			
	Rev. (M)	Chg.	% of Rev.
Total	$578.0	2.2%	
Waters Div.	$515.8	2.4%	89%
Instrument Systems	$239.0	0.2%	41%
Chemistry	$96.0	3.3%	17%
Service	$180.8	4.8%	31%
TA	$62.2	0.9%	11%
Instrument Systems	$43.6	-1.5%	8%
Service	$18.7	7.0%	3%

Waters third quarter revenues grew 2.0% in constant currency, as constant currency sales for the Waters Division and TA Instruments increased 3.0% and 1.0%, respectively (see ***IBO*** 10/31/18). All figures below are in constant currency. Both instrument and chemistry sales led growth with both rising 6.0% in the third quarter, followed by service sales, with a 4.0% increase.

Waters Q3 FY18			
Adj. Op. Profit (M)	Chg.	Adj. Op. Margin	Chg. (bps)
$175.4	5.0%	30.3%	80

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Waters saw unexpected weakness in two key areas: slow sales of its TA Instruments product line and low demand in the European pharmaceutical market. TA instruments revenue only grew 1.0% due to the timing of certain shipments to the US, Europe and China. The company attributed the low sales in the European pharma market to uncertain political dynamics, such as the ongoing Brexit situation.

Academic and government sales were strong in both the environmental research and pharmaceutical discovery sectors, which offset weak sales in the biomedical research sector.

Waters Q3 FY18				
	Rev. (M)	Chg.	Constant Curr. Chg.	% of Rev.
Asia	$222.2	6.1%	7%	38%
Americas	$206.8	1.9%	2%	36%
Europe	$149.0	-2.7%	-2%	26%

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On a geographical basis, Chinese demand rose 14.1% to make up 19% of total Waters sales. India's sales remained modest due to country-specific political uncertainty, such as a weak rupee and upcoming elections. Despite strong sales in Canada and Latin America, Americas revenue experienced a slight decline, due to weak sales of the TA Instruments product line in the US.

Waters Q3 FY18				
	Rev. (M)	Chg.	Constant Curr. Chg.	% of Rev.
Pharmaceutical	$325.2	1.0%	2%	56%
Industrial	$172.0	2.2%	2%	30%
Govt. & Academic	$80.9	7.4%	8%	14%

By product line, global pharma sales grew thanks to the high demand for service application kits, UPLC columns and bioseparation columns. Thermal analyzers experienced soft sales, but this was offset by the strong sales of the company's rheology, microcalorimetry and ElectroForce product lines.

Waters forecasted fourth quarter organic sales to increase 3%–4%, with currency subtracting 1%–2% growth. The company decreased its annual sales guidance to 3%–4% growth from 4%–6%, excluding currency effects.

Microcalorimetry

Broadly speaking, calorimetry is the measurement of heat transferred into or out of a system due to some transition in the sample, whether it be a chemical reaction, binding or other change of state, such as a phase transition. As the name suggests, microcalorimetry involves similar measurements, but at a micro-scale, not only in terms of the amount of heat generated, but also the actual physical size of the sample, often on the order of about 1 mL of solution or less. Using small samples offers both challenges and benefits. It can be challenging to be sensitive to the small changes involved, and also to guard against stray thermal influences in the environment. At the same time, some modes involve controlling the temperature of the sample, and it is much easier to rapidly change or control the temperature of a small sample. While any type of transition in a sample could be examined with microcalorimetry, the field has a strong focus on the interactions of life science molecules, particularly in the context of pharmaceutical and biopharmaceutical products and their interaction with proteins and other molecules of interest, in order to study binding affinity, enzyme kinetics, conformational effects, molecular stability and other thermodynamic properties.

Several specific methods for standard calorimetry have also been adapted for microscale calorimetry. Some systems can support multiple modes of microcalorimetry, while others are more special purpose for a single testing mode. Probably the most common mode is isothermal titration calorimetry (ITC). The heart of this type of measurement is in the heat flow, which is achieved by measuring the differences between the thermal response of the sample cell and a reference cell of identical size and shape. The cells are simple chambers made from materials designed to withstand both corrosion and temperature extremes. While the reference cell contains only water or a standard solution, the sample cell also contains one of the two solution of interest. The cells share a common

temperature bath, and a thermocouple provides a very sensitive means of noting any differences in temperature between the two cells.

Once the cells are prepared, the titration system injects a solution containing the second molecule into the cell, either continuously or in controlled volumes at set times. When the molecules react, heat can be either produced or absorbed by the reaction, affecting the temperature of the sample cell. A precise heating system drives the sample cell in order to maintain it at the same temperature as the reference cell. Over the course of the experiment—usually on the order of hours—the instrument's primary measurement is the power supplied to keep the temperature the same. Through integration and standard thermodynamic identities, this information can be converted into heat of reaction, enthalpy change and other information about the kinetics of the reaction as a function of time or the relative molarity of the two compounds.

Another possible calorimetry mode used in microcalorimetry is differential scanning calorimetry (DSC). Rather than studying the interactions of two molecules as in ITC, this technique is more suited to studying the behavior of a single molecule or material under changing temperature conditions. The temperature of the sample is scanned through a range by applying a constant power or heat flux to the sample, and the thermal response of the sample (compared to the reference cell) is measured. This can be used to study phase transitions and other properties of the sample.

Pharmaceutical and biotherapeutic applications are the most common for microcalorimetry. The interactions between potential therapeutic compounds and proteins of interest, as well as the stability of the compounds themselves, can be studied with these methods, providing some complementary information to other techniques, such as SPR. In principle, other types of samples can also be studied, but these applications involving chemicals, catalysts, battery materials and other advanced materials science applications are in the minority.

Relatively few vendors compete in the microcalorimetry market. Malvern Panalytical (Spectris) is the leading vendor in the marketplace, having acquired the MicroCal line from GE Healthcare in 2014 (see ***IBO*** 6/15/14). The company offers both microDSC and microITC in a few different configurations for specific applications primarily within biopharma and the research community. TA Instruments (Waters) is the next most significant vendor, again addressing the market with a broad portfolio of instruments, including some with multiple cells for greater throughput. Setaram, the French thermal analysis specialists, are the next largest vendor, offering a high-pressure microcalorimeter for the study of gas hydrates. Another notable market participant is Rigaku, which supplies microDSC as a highly complementary technique to its XRD business. Other suppliers

include Symcel and Thermo Hazard Technology, which has a microcalorimeter designed for cell biology applications.

Microcalorimetry at a Glance:

Leading Suppliers

- Malvern Panalytical (Spectris)
- TA Instruments (Waters)
- Setaram

Largest Markets

- Pharmaceuticals
- Biotechnology
- Academia

Instrument Cost

- $15,000–$100,000

Academia

Startup companies originating from universities, colleges and other research centers have been thriving, with 32%, or 1,080, new startups established in 2017, according to a survey of 193 institutions. The increase in startup companies underlines the importance of technology transfer offices that can help take products to the marketplace, as over $3 billion in gross licensing revenue was reported in 2017. Total R&D expenditures for these institutions in 2017 grew nearly 2%, or $1.3 billion, with data indicating that institutions are focusing more on unconventional sources of funding and partnerships. Federal R&D funding increased slightly, but is expected to remain relatively flat in the near future, and industrial funding declined 2.1% in 2017, the first decline since 2011. “Other” R&D sources, such as grants from nonprofits or state/city grants, are outpacing federal and industrial funding.

In 2017, 24,998 invention disclosures were reported, a 3.2% decline and the first decline since the survey’s inception in 1991. It remains unclear whether disclosures will again begin to rise or if they have reached a plateau. The most-ever patents were reported in 2017 at 7,459, although the number of patent applications, including new provisional and utility patents filed in the US, fell 5.7%,

echoing the trend of declining US utility patent applications over the past three years. This decline may be attributed to issues regarding patent rights in the US due to recent Supreme Court filings.

Licensing is the next step in commercializing protected IP, and in 2017, 2,037 exclusive licenses were granted, a 1.3% decline. In contrast, the number of options and non-exclusive licenses grew 1.2% and 1.9%, respectively. Analyzed together, these data may point towards declining risk-taking on the part of commercial entities for university licenses.

Successful technology transfers result in a new product in the marketplace, and in 2017, 755 new products were released in the market, a 5.4% decrease. Between 2007 and 2012, new product levels were flat, but in 2014, that figure spiked 34.2%; however, numbers have since decreased back to 2013 levels.

Source: *Association of University Technology Managers*

Oil, Gas & Chemicals

Company executives have a positive outlook for the oil, gas and chemicals markets, according to a survey consisting of 325 interview with experts in the oil, gas and chemicals industry. Upstream companies are focusing on near-term strategies, specifically lowering costs, increasing efficiency and maintaining robust production. Fifty six percent of upstream executives also plan to increase exploration and development expenditures, while 61% and 56% plan to grow rig deployment and staffing in 2019, respectively. Midstream companies are investing in infrastructure, thanks to growth in both upstream and downstream operations. These companies are also focusing on natural gas and natural gas liquids, as they have a more favorable commodity price outlook.

Continuing moderate growth is the top priority for downstream companies, which expect to increase refining margins, exports and capital expenditure spending. The Gulf Coast was cited by 62% of respondents as the region with the most opportunities, with the Pacific Coast, Midwest and Appalachia, Rocky Mountains and the East Coast following, with 44%, 39%, 37% and 31%, respectively. Oil-based infrastructures were listed as having the greatest potential for growth, jumping 28%, while natural gas gathering and processing potential grew 6% and refined oil product pipelines grew 3%. The growth potential for natural gas pipelines fell 11%.

Downstream firms are focusing on costs and regulations, including environmental regulations. Most downstream companies have a positive forecast of modest growth, as export volumes are at record highs and predicted to continue their upward trend, as 72% of executives expect a net increase.

About 64% expect a net increase in downstream spend, with 48% predicting up to a 10% increase in their spending.

Chemicals and specialty materials cited consolidation opportunities, digitization and overall growth in the sector as areas of interest, but, similar to downstream companies, chemicals and specialty materials firms are concerned about regulations. Risks within political administrations around the world, and fluctuating customer expectations were also listed as concerns, while innovation, sustainability and the supply chain are the highest-priority strategic sectors within the industry. Approximately 85% of respondents believe the chemicals sector is digitally mature at a moderate to high level.

Sixty percent forecast M&A activity to rise by 2019. Consolidation through M&A was seen as a major key strategy across all sectors. Oil and gas companies expect oilfield services as having the greatest potential for consolidation, while chemicals executives expect most consolidation to take place in their own sector.

Source: *Deloitte*

R&D

In a survey of the world's 1,000 biggest publicly listed corporate R&D spenders, known as the "Global Innovation 1000," data indicated that 2018 R&D expenditures jumped 11.4% to $782 billion, a record high figure. R&D spending increased in all regions and almost all industries. Eighty-eight companies, categorized as high-leverage innovators, experienced sales growth that was 2.6 times greater from 2012 to 2017 than other companies on the Global Innovation 1000, and market capitalization growth that was 2.9 times greater. These companies achieved this while keeping their R&D intensity, defined as R&D expenditures as a percentage of sales, lower than the industry average.

Year over year spending growth in 2018 was approximately four times greater than growth between 2016 and 2017, and revenues for the Global Innovation 1000 also grew 11.4%, while R&D intensity remained the same from 2017 at 4.5%. Total spending on R&D by the top 20 companies in the Global Innovation 1000 was $214.5 billion, 27% of total spending. The top 20 list was led by Amazon, with R&D spending of $22.6 billion, a 40.6% increase. Similar to last year, Amazon was followed by Alphabet, with R&D spending of $16.2 billion, up 16.3%.

Industry wise, chemicals and energy were among the few industries that did not increase R&D expenditures in 2018, while computing and electronics, health care, auto, and software and internet accounted for 76% of total R&D spending among the Global Innovation 1000. China and Europe were the regions with the greatest investments in R&D at 34% and 14%, respectively. Companies in North America, Japan and Rest of World increased R&D spending in the single digits. North America led the number of innovative companies across a variety of sectors, including health care, for which it accounted for 49% of companies.

Source: *PwC Strategy + Business*

Greece

In 2017, R&D expenditures in Greece totaled €2.0 billion ($2.3 billion), a 15.9% jump, while the nation's R&D intensity indicator, which is R&D expenditure as a percentage of GDP, grew 0.1% to 1.14%. All sectors increased R&D spending in 2017, with the business and government sectors growing R&D expenditures 33.8% and 2.1% to €990.8 million ($1.1 billion) and €448.1 million ($511.2 million), respectively. The higher education sector's R&D expenditure grew 3.3% to €577.7 million ($658.5 million), while the private nonprofit sector's R&D spending rose 5.1% to €16.4 million ($18.7 million).

For most of these sectors, the vast majority of funding was sourced by the sector itself. In the business sector, 84% of R&D expenditure was self-funded, with the government and higher education sectors self-funding 76% and 67% of total R&D expenditures, respectively. Only in the private nonprofit sector did the majority of funding come from outside sources, as the sector self-funded 40% of R&D expenditures. In 2017, R&D intensity in the business sector was 0.56%, an increase of 13 basis points, and 0.25% in the government sector, for which R&D intensity remained flat. In the higher education and private nonprofit sectors, R&D intensity also remained flat at 0.325% and 0.01%, respectively.

The main source of foreign funding was the European Commission (EC) through its Framework Programs for Research, which includes programs such as Horizon 2020. In 2017, the EC provided €215.1 million ($245.5 million) in R&D funding, a 3.2% increase. Per its 2017 R&D expenditures, Greece ranked 16th among EU28 countries.

Full-time R&D personnel and researchers also increased in 2017, growing 15.4% and 19.7%, respectively. The higher education sector led with 17,861 researchers, and was followed by the

business sector with 10,664 researchers, government with 6,372 researchers and the private nonprofit sector with 289 researchers.

Source: *National Documentation Center*

UK

In its 2018 budget, released in late October, the UK government provided funding for innovations in science and technology that will specifically boost the nation's economy, create skilled jobs and improve living standards. Prioritizing long-term funding for research, R&D funding totaled £1.6 billion ($2.1 billion) to strengthen science and international collaboration. Over the past 3 years, the UK government invested an additional £7 billion ($9.0 billion) in R&D, which is the UK's largest rise in R&D funding in 40 years.

The Industrial Strategy Challenge Fund, aimed at fostering science and business innovations, received an additional £1.1 billion ($1.4 billon). The Fund, which was established last year, receives funding in waves and has already garnered £1 billion ($1.2 billion) for research in sectors such as robotics, next generation battery technology, AI, clean and flexible energy, and space technology. The additional billion it is receiving in the 2018 budget includes up to £121 million ($155.8 million) for manufacturing digitally enabled technologies, such as IoT and virtual reality, and up to £78 million ($100.5 million) for the Stephenson Challenge for innovation in electric motor technologies.

The UK is heavily focusing on becoming a leader in digitization, providing generous funding for digital technology development. Quantum technologies R&D received £232 million ($298.8 million), including £35 million ($35.1 million) for a national quantum computing center. AI R&D received up to £950 million ($1.2 billion) through the Industrial Strategy Artificial Intelligence and Data Grand Challenge initiatives. On top of the £1 billion ($1.2 billion) it has already received in long-term funding, the Digital Catapult program obtained an additional £115 million ($148.1 million), which provides access to cutting edge technologies to entrepreneurs and businesses.

The government also announced a new fund for science and innovation of £50 million ($64.4 million) per year. The fund, launching in 2021–2022, is for addressing challenges in the sciences, including public health and cybersecurity, and will concentrate on joint projects between government and industry. Additionally, £120 million ($154.6 million) was allocated to clusters of science and innovation through the Strength in Places Fund, which extends the existing Fund until 2021–22.

Source: *HM Treasury, Government of UK*

China

The Chinese government has been investigating researchers and science firms that break data-sharing rules on citizens' genetic data and material, with some scientists worrying the scrutiny is negatively impacting international research partnerships. Five companies and a research hospital were identified by the Chinese government in October, accused of violating sharing regulations that have been in place since 1998. These organizations were suspected of transferring human DNA samples or genetic data to other organizations in China or internationally without receiving permission from the Chinese science ministry's human genetics office.

AstraZeneca's Shanghai research center was caught transferring samples for creating diagnostic tests for predisposition to breast cancer to two Chinese companies, one in Xiamen and one in Beijing. Although the company was allowed to collect the samples, AstraZeneca claimed ignorance in needing authorization to transfer the genetic material to another entity in China.

BGI and Huashan Hospital in Shanghai were also accused of similar conduct: posting genetic information online without any approval as part of a large international study on the genetics of depression. The study was published in *Nature* in 2015 and was based on sequence data of over 10,000 Chinese women, and BGI recognized that it published the information without adequate permission. By request of the ministry, BGI stated that it has destroyed the data and requested the article be removed from *Nature*, although currently the article is still online. Both companies have accepted penalties from China's government and although specific research projects were set back, the companies stated that they have not had any overall issues with their research.

Scientists and policymakers are concerned that the investigation may discourage scientists from sharing genetic data that has been collected in China, especially in this age of data sharing and transparency. While many countries have rules about how their citizens' genetic material and data can be shared, the rules are not supposed to interfere with research, which is what scientists claim is happening in China. If the government continues to enforce the regulations, researchers worry that the country may become isolated from international research groups involved in genetic research.

Source: *Nature*

Broad-based Companies

Company Announcements

In October, **AMETEK India** established the $5.5 million Technology Solutions Center at its facility in Bangalore, India. The Center houses instruments from 20 AMETEK companies.

AMETEK named Keith Reazin as vice president and general manager of its Instrumentation and Specialty Controls Division in November. Mr. Reazin had been Division vice president and Business Unit manager for AMETEK Aerospace & Defense's Power and Data Systems business.

In October, **HORIBA Korea** consolidated three sites and transferred operations to a head office and factory in Anyang, with a floor area of 81,946 ft^2 (7,613 m^2). The production area features new capabilities to produce large-scale products.

Illumina Accelerator announced in October its 8th investment cycle consisting of investments in 5 startups: therapeutic discovery firm **Algen Biotechnologies**, which is developing a platform for decoding functional gene networks; personalized medicine company **Astarte Medical Partners**, a designer of software for the analyzing gut health in order to improve care of preterm infants; **Avial Bio**, a precision oncology business working to optimized patient response to cancer therapeutics; molecular diagnostics firm **Cognitive Genetics**, a developer of tests for pre-symptomic risk assessment of common reading and learning disabilities; and drug discovery firm **VastBiome**, which aims to mine the gut microbiome.

Illumina announced in November that Mark Stapley, executive vice president, Strategy & Corporate Development, plans to leave the company effective January 1, 2019.

Fiscal 2018 sales for **Precision System Science** for the year ending June 30 declined 5.4% to ¥3,641 million ($330 million) (see ***IBO*** 10/15/18) due to a decline in OEM sales. Instrument, Reagent Kit & Consumables and Customized Product sales fell 3.8%, 12.3% and 11.2% to represent 52%, 27% and 12% of total sales, respectively. Maintenance revenue rose 19.7%. The company forecasts fiscal 2019 sales of ¥4,300 million ($390 million).

Techcomp shareholders voted in October to change the company's name to **Yunnan Energy International**.

In October, **Harvard Bioscience** named Kam Unninayar as CFO, effective November 26. Most recently, she was CFO at **Tetraphase**, a clinical-stage biopharmaceutical company.

BD (Becton, Dickinson) announced in October a $200 million investment in its facilities in Nebraska, creating 300 new jobs.

Third quarter revenue for **Sartorius**' Lab Products & Services Division rose 7.4%, 9.7% in constant currencies, to €310.7 million ($345.2 million) (see ***IBO*** 10/31/18), including 3.5% sales growth from the Essen Bioscience acquisition (see ***IBO*** 3/15/17), with softer demand reported for Europe. The company lowered 2018 revenue growth guidance for the Division from 12%–15% to 8%–10% in constant currencies, including 2.5% growth from Essen. Bioprocess Solutions Division sales grew 12.2%, 14.8% in constant currencies, to €843.0 million ($936.7 million).

In October, **Agilent Technologies** named Eric Gerber as senior vice president of Strategy and Corporate Development, effective November 1. He previously served as vice president of business development at **SCIEX**.

Building upon its Frederick, Maryland, campus, **Thermo Fisher Scientific** opened in October a new business center and biorepository. Newly expanded by more than 190,000 ft^2 (17,652 m^2), the center will serve as the North American hub for Thermo Fisher's life sciences business. The new building is the largest building on the campus with more than 80 employees. The expansion includes another 22,000 ft^2 (2,044 m^2) to accommodate future growth and advancements in automation, bringing Thermo Fisher's total investment in the facility to nearly $10 million. The expansion also adds a 77,000 ft^2 (7,154 m^2) facility to house a dedicated Cryo-Innovation Center and National Cancer Institute Repository for Clinical Trials. Another 15,000 ft^2 (1,394 m^2) has been reserved for future expansion.

In November, **Thermo Fisher Scientific** named Jim Mullen to its Board, bringing the total number of board members to 12. Mr. Mullen previously served as CEO of **Patheon** and also currently a director at **Insulet** and **Editas Medicine**.

GE Healthcare reported third quarter Life Sciences revenue grew 5%. Life Sciences orders increased 6% on an organic basis, including a 9% increase in bioprocess orders.

In November**, Merck KGaA** signed an agreement with the **Guangzhou Development District** to establish an innovation hub in Guangzhou, which is scheduled to open September 2019. The 7,535 ft^2 (700 m^2) hub will be equipped with a showroom to demonstrate Merck's latest technologies,

innovation projects and future research direction of the three business sectors of Merck, Healthcare, Life Science and Performance Materials.

Bruker disclosed in its third quarter 10-K filing that in August, the **Korea Fair Trade Commission** informed the company of an investigation into the activities of a number of life science instrument companies operating in Korea, including Bruker Korea. Korean revenue represented less than 3% of the company's nine month sales.

Shimadzu Scientific Instruments announced in November a collaborative relationship with **EVIO Labs Florida**, a medical marijuana testing lab.

Sequencing

Company Announcements

BGI announced in September a collaboration with **Maxwell Plus**, a machine learning medical technology company, on a project entitled, "A model to predict the risk of developing advanced or metastatic prostate cancer using genetic makeup and family history of cancers." All samples will be sequenced on BGI's MGISEQ-2000 sequencer at its Australian laboratory.

In October, **Genoox**, a cloud-based system for clinical genetic analysis, partnered with **Microsoft Healthcare** to bring the **Microsoft Genomics** service to its customers. The companies plan to offer the Microsoft Genomics service for secondary genomic analysis to selected Microsoft Enterprise users.

Bionano Genomics, maker of the Saphyr genomic platform, and **Genoox** launched the Genoox Integrated Platform for the identification of structural variants in October. Genoox technology can be used to align short-read sequence data with Bionano's structural variant calls. The companies will co-sell and co-market the integrated platform.

Eagle Genomics announced in October a partnership with **Microsoft Genomics**, the first microbiome partnership for Microsoft Genomics. Eagle Genomics' e[automateddatascientist] platform will be available to Microsoft Enterprise users.

In October, **Sanofi Genzyme** and **PerkinElmer Genomics** launched the **Lantern Project** to offer access in the US to free diagnostic genetic testing for a number of lysosomal storage disorders.

Genialis, a provider of data integration solutions, partnered in October with **Roche** to provide a streamlined NGS workflow for gene expression profiling using Roche's KAPA RNA HyperPrep Kit.

DNAnexus announced in October that it has been granted an Authority to Operate under the Federal Risk and Authorization Management Program (FedRAMP) for the management and analysis of biomedical data on its cloud-based platform. FedRAMP is a US government-wide program that provides a standardized approach to security assessment, authorization and continuous monitoring for cloud products and service. The DNAnexus Platform is the only industry or federal cloud-based platform for biomedical informatics and data management granted authorization under FedRAMP sponsored by the **DHHS**.

In October, **Thermo Fisher Scientific**'s Oncomine Dx Target Test was CE-IVD marked as an IVD for detection of 46 cancer-driver gene variants.

Thermo Fisher Scientific's Oxoid business entered into a comarketing and distribution agreement with **SGS MOLECULAR** in November. Thermo Fisher will exclusively sell SGS' All Species ID DNA Analyzer Kits and SGS All Species ID Software as part of an end-to-end workflow solution for the food and beverage market on Thermo Fisher's NGS platforms. The NGS workflow enables multi-species screening and identification for food authenticity.

Genomics service company **BGI Americas** and **Gencove**, a genomics technology company, entered into an agreement in October to offer a new low-pass sequencing service to lower barriers to large-scale genomics projects. This service combines BGI's DNBseq Next Generation Sequencing technology and Gencove's ImputeSeq low-pass sequencing analysis pipeline. The solution will be available in the Americas as a complete turn-key service from both companies.

Agricultural genomics company **NRGene** announced in October a partnership with cannabis breeding firm **Kayagene** to develop cannabis varieties for hybrid seed production through stabilized lines.

In October, **Fabric Genomics**, a provider of clinical interpretation software for genomic data, and **Genomenon**, a genomic data search company, entered into an integration and comarketing agreement.

In October, **Congenica**, a diagnostic decision support platform provider, partnered with the UK's **Epilepsy Society** to study the genomics of sudden unexpected death in epilepsy.

Dovetail Genomics named new distributors in October: **Premas Life Sciences** for India; **Millennium Science** for Australia and New Zealand; **Genomics Bioscience** for Taiwan; **Ultravision Technology** and **Shanghai Biozeron Biotechnology** for China; **Bio-Active** for Thailand; and **Biomedic Science Material** for Vietnam.

In October, **Paragon Genomics** partnered with **SOPHiA GENETICS** to incorporate its CleanPlex NGS target enrichment technologies into SoPHIA's AI Platform. The solution provides a comprehensive and standardized solution for accurate genomic detection and characterization of all types of tumor alterations in a single test.

In November, **Blue Cross Blue Shield** announced in November a partnership with Illumina to determine the availability and clinical understanding of DNA sequencing technologies, genetic testing and precision medicine. The companies plan to identify areas across the country where people can access these services and where there is limited access. The project is expected to be completed in early 2019.

Product Introductions

In September, **Thermo Fisher Scientific** launched a new workflow for its Oncomine Tumor Mutation Load Assay to provide more flexibility in tumor mutation burden experiment designs, while simultaneously providing sample profiling capabilities for key variants associated with published evidence across 409 cancer-related genes.

Expanding beyond proteomics tools, **ABclonal Technology** introduced in September two DNA library preparation kits and two RNA library preparation kits. The Rapid DNA Lib Prep Kit and StepWise DNA Lib Prep Kit starts at $218 per kit. The Stranded mRNA Lib Prep Kit and NonStranded mRNA Lib Prep starts at $558 per kit.

In October, **Oxford Nanopore** released a new version of the MinION and GridION flow cells that include the new 'Rev D' ASIC. The new release extends the amount of time that flow cells can be used for DNA sequencing or RNA sequencing, increasing the overall yields of DNA sequence data

to as much as 30 Gb per flow cell (at this performance, the equivalent of ~10X human genome for $500).

Oxford Nanopore launched in October the MinIT, a rapid analysis and device control accessory for the MinION DNA/RNA sequencer to enable real-time, high-throughput data analysis.

In October, **Fabric Genomics** announced it is offering select customers the option of using Build 38, the most current reference genome assembly. Fabric Genomics has processed more than three thousand patient genomes on Build 38 for **Genomics England**.

QIAGEN launched in October the QIAseq FastSelect RNA Removal Kit. Off-the-shelf options include rRNA or globin mRNA removal, while custom RNA removal solutions for selected transcripts can be designed by QIAGEN.

In October, **QIAGEN** introduced QIAGEN Clinical Insight (QCI) Analyze Universal for full end-to-end workflow support of all major clinical sequencing platforms and assay types. The company also released an improved QCI Interpret somatic cancer clinical decision support application.

In October, **1010 Genome** launched a data analysis service for NGS applications. The company specializes in the development of optimized and customized data analysis workflows.

Swift Biosciences introduced in October the Normalase Kit for enzymatic library normalization, its first foray beyond library preparation. The Kit employs a two-step workflow. The first Kit available is suitable for libraries with full-length indexed adapters that have been added by ligation.

In October, informatics firm **SOPHiA GENETICS** debuted Alamut Genova, an advanced variant exploration software for genomic data visualization and interpretation, the latest evolution of Alamut Visual. Novel features, including ACMG/AMP classification, 3D protein visualization, Sanger electropherogram visualization and new splicing predictions that complete the existing solution.

DNAnexus, a biomedical informatics and data management company, launched in October the DNAnexus Apollo, an enhanced platform for clinico-genomic data science exploration, analysis and discovery. It provides a scalable cloud environment and flexible data models.

In October, **BGI** debuted the MGISEQ-T7 sequencer, featuring a quadruple flow-cell staging that allows simultaneous but independent operation of 1 to 4 flow cells in a single run. It is capable of daily output of data up to 6 Tb.

Illumina debuted in October the TruSight Oncology 500 (TSO 500), which utilizes both DNA and RNA from subject tumor samples to identify key somatic variants underlying tumor progression, such as small DNA variants, fusions and splice variants. TruSight Oncology 500 can measure tumor mutational burden and microsatellite instability. It will ship in the first quarter of 2019.

In October, **Agilent Technologies** released the Agilent OnePGT, a genome-wide NGS solution for preimplantation genetic testing (PGT). OnePGT allows parallel detection of multiple monogenic disorders (PGT-M), translocations (PGT-SR) and aneuploidies (PGT-A) on a single biopsy.

Sales and Orders of Note

In October, **Personalis**, a provider of advanced genomic sequencing and analytics for immuno-oncology, announced an extension to its contract with the **US Department of Veterans Affairs** to sequence a further 34,000 whole human genomes for the **Million Veteran Program** (MVP). This brings the total of all Personalis contracts from the MVP to almost 80,000 human genomes.

Genomic data management and analytics firm **BC Platforms** launched in June its genomics platform for **HUS**, **the Hospital District of Helsinki and Uusimaa**, the largest healthcare service provider in the whole Nordics region.

Congenica, the provider of a diagnostic decision support platform, announced in October that it was awarded a multi-year contract by **Genomics England** to be a provider of Diagnostic Decision Support Services.

In October, **HTG Molecular Diagnostic,** which provides NGS-based molecular profiling solutions, announced that Switzerland's **Institute of Oncology Research** has adopted the HTG EdgeSeq technology at its genomics facility.

Life Science Instruments

Company Announcements

Under an agreement announced in July, **LI-COR Biosciences** agreed to license IRDye QC-1 quencher technology and provide cGMP custom manufacturing services to biotech firm **Vergent Bioscience**.

In October, **NanoString Technologies**, a provider of life science tools for translational research and molecular diagnostic products, announced that the **University of Oxford** has been selected as the winning recipient of a grant for a GeoM Digital Spatial Profiler (DSP) as part of the DSP grant program. The grant program included more than one hundred submissions from around the world.

NanoString Technologies entered into a translational research agreement in October to identify and develop biomarkers for **MacroGenics**' MGD013 program.

In August, **MBio Diagnostics**, provider of the LightDeck planar waveguide technology, raised an additional $6 million in Series B financing in August, including its new strategic veterinary partner **Heska**.

In October, **Fluidigm**, a mass cytometry and microfluidics technology company, named Laura M. Clague to its Board. She is CFO of biopharmaceutical company **Retrophin**.

Product Introductions

In November, **NanoString Technologies** debuted the nCounter CAR-T Characterization Panel for the molecular characterization of CAR-T cells in research, development and manufacturing. This customizable, 780-gene expression panel incorporates content to measure eight essential components of CAR-T cell biology including T-cell activation, metabolism, exhaustion, and receptor diversity with optional customization for measuring transgene expression with NanoString's Protein Barcoding Service.

Gene-based Instruments

Company Announcements

PathogenDx, a provider of DNA-based pathogen testing technology announced a $3.4 million capital raise in July, completing the company's convertible note round. The PathogenDx capital raise was co-led by **Altitude Investment Management** and the **Panther Opportunity Fund**.

In September, **LuminUltra**, a developer of portable microbiological monitoring tools, acquired I**nstantLabs**, which provides point-of-use qPCR-based and NGS products and services.

LGC Axolabs announced in October an 8,611 ft^2 (800 m^2) addition to its site Kulmbach, Germany, to expand the capacity of its specialist therapeutic oligonucleotide development solutions business and create a new GMP analytical capability. The addition expands the total site capacity to 48,438 ft^2 (4,500 m^2) and 100 scientists. The expansion is due to open in February 2019.

In October, **Fluidigm** entered into a non-exclusive distribution agreement with **DNA Software** to provide CopyCount-CNV software for use with the **Fluidigm** Biomark HD, a qPCR system.

Product Announcements

In August, **Eppendorf** extended its range of PCR accessories with a new software application, the CycleManager X50, for the remote control of up to 50 Mastercycle X50 eco modules.

Fluidigm and **GenomOncology** announced in September an expanded Immuno-Oncology Gene Expression Workflow to accelerate the development of checkpoint immunotherapies and the identification of potential predictive biomarker signatures for therapeutic response. The integrated solution spans RNA extraction through data analysis with optimized software from **GenomOncology**'s the GO Immuno-Oncology Workbench.

In September, **UgenTec** released FastTyper end-point PCR analysis software, which uses AI methods to accelerate genotyping analysis workflows and improve data interpretation in applications such as agricultural breeding programs.

Ubiquitome introduced in October the Liberty16 mobile real-time PCR system, with a starting price of $1,500. Built-in lithium batteries provide 2–3 hours of mobile running time.

Sales and Orders of Note

In November, **Bio-Rad Laboratories** was awarded a contract for its iQ-Check real-time PCR pathogen detection test kits and the iQ-Check Prep Automation System from the **USDA Food Safety and Inspection Service**. The contract includes real-time PCR-based tests for pathogens that include Salmonella spp., Listeria monocytogenes, Campylobacter, Escherichia coli O157:H7 and Shiga toxin producing E. coli (STEC).

Cell-based Instruments

Company Announcements

In October, following installation the triple modality AnyScan (SPECT/CT/PET) system, **Mediso Medical Imaging Systems** began a scientific collaboration with the UK's **National Physical Laboratory**.

Berkeley Lights, a digital cell biology company, announced in October the completion of a $95 million financing led by **Nikon**. New investors include **Varian**.

In October, cell-line developer **Selexis** and **Berkeley Lights** announced a collaboration around the acquisition of Berkeley Lights' Beacon optofluidic platform. The partners will leverage the technology to accelerate cell line development with the Selexis SUREtechnology Platform.

Fluidigm announced in October the publication of the 10,000 Immunomes Project (10KIP), a human immune reference standard containing mass cytometry immune cell profiles, by investigators at the **University of California, San Francisco** and **Northrop Grumman Information Systems Health IT**.

Proteona entered into an exclusive worldwide licensing agreement in October with the **National University of Singapore** for Enhanced Single Cell Analysis with Protein Expression (ESCAPE) RNA sequencing Technology. Proteona is pioneering the use of validated multiplex panels of DNA-barcoded antibodies to provide proteomic information in addition to total mRNA sequence data from single cells.

In November, single-cell analysis firm **1CellBio** partnered with **the Open Medicine Institute**, an independent precision medicine clinical and research organization, to apply and validate its inDrop system as part of a clinical research project to investigate the potential for single-cell RNA-sequencing technology in precision medicine applications. The collaboration will initially focus on generating predictive data for patients with an undiagnosed immune dysfunction condition.

Product Introductions

In October, **ACEA Biosciences** released the xCELLigence RTCA Software Pro. an integrated software package designed specifically for immune-oncology applications, for its xCELLigence Real Time Cell Analysis instruments.

BioTek Instruments introduced in October the AutoScratch Wound Making Tool to facilitate 2D collective cell migration and invasion applications. It automatically creates consistent scratches of equivalent size and area in confluent cell monolayers grown in 24- or 96-well microplate formats.

In October, **Cytek Biosciences** launched the value-added Cytek Northern Lights series of flow cytometer systems, which can be configured for 1 laser for 1–9 colors or 3 lasers for more than 24 colors.

Celsee introduced in October the Genesis system for single-cell analysis. The system uses a gentle, gravity-based method to capture and isolate individual cells while maintaining viability and structural integrity. It uses Celsingle micro analysis slides to capture and isolate individual cells. Celsingle slides have the capacity for up to one million cell-isolation microwells.

In October, **Menarini Silicon Biosystems** announced the launch its DEPArray FFPE SamplePrep Kit for its DEPArray system, calling it the first commercially available kit for the disaggregation and staining of FFPE tissue sections down to a single-cell suspension.

Poietis released in October a new range of NGB (next generation bioprinting) systems for tissue engineering, integrating all bioprinting techniques (laser, extrusion, inkjet by micro-valve). The NGB-R is designed for research markets and the NGB-C is a clinical version designed for Advanced Therapy Medicinal Products production.

In November, **Dolomite Bio** launched a high-throughput single nuclei RNA sequencing protocol for its Nadia Instrument, enabling researchers to cost effectively profile both complex and archived tissues.

Sales and Orders of Note

In September, **Nanion Technologies** announced the placement of two SyncroPatch 384PE high-throughput clamp patch instruments at CRO **Charles River Laboratories**.

In October, **Mediso USA** announced the 100th installation of a MultiScan LFER 150 PET/CT system, which was placed at the **Tulane National Primate Research Center**. The Center is the 4th site in North America to install one of the systems. The system will support infectious disease research.

Bruker announced in October the installation of a high-field 4 T small animal preclinical MRI system with integrated, in-line PET at the **Germany Cancer Research Center (DKFZ)** in Heidelberg, Germany. The system is installed at the DKFZ Division of Medical Physics in Radiology.

Protein-based Analysis

Company Announcement

In October, **Quanterix** announced a collaboration agreement with OncoGenesis, a molecular protein-based cervical screening company, to develop a quantitative, protein biomarker diagnostic test for cervical health. The two companies will jointly complete the development of the test on Quanterix' forthcoming SP-X Imaging and Analysis System, and OncoGenesis will commercialize the test in developing countries.

Expedeon announced in November a supply and license agreement with **Quanterix** for its CaptSure immunoassay technology for single-target analysis, as well as for its Lightning-Link conjugation technology for antibody labelling.

Product Introductions

In November, **Quanterix** announced an early access program for its 10-plex assay for oncology research and drug development and the benchtop SP-X Imaging and Analysis System, both utilizing a planar array technology. The SP-X system expandes the company's Simoa franchise into oncology and immune-oncology research.

Atomic Spectroscopy

Company Announcements

In October, **Hitachi High-Tech Analytical Science** named **LABCONTROL** as the exclusive Brazilian distributor for its atomic spectroscopy product lines.

Hitachi High-Tech Analytical Science moved its US corporate office in October to a new location in Westford, Massachusetts, marking the final phase in the transition resulting from the sale of **Oxford Instruments Industrial Analysis** to Hitachi High-Technologies (see ***IBO*** 4/30/17).

In October, **Quantum Analytics** entered into a distribution agreement for **Bruker AXS**' S2 PUMA and S2 POLAR ED-XRF systems, as well as the D2 PHASER XRD system.

Product Introductions

Hitachi High-Tech Analytical Science introduced in October the entry-level XMET8000 Smart model. The new model allows users to pick up to three calibrations: Alloy FP, Aluminum FP and Precious FP.

In October, **Bruker** launched the S2 POLAR , a new multielement benchtop analyzer based on polarized ED-XRF. The S2 POLAR analyzes ultra-low sulfur content and achieves detection limits in the sub-ppm range for gasoline, kerosene and diesel.

VELP announced in October the CN 802 combustion analyzer for carbon and nitrogen determination. It features flash determination of carbon and nitrogen content in 34 minutes, and connection to the VELP Ermes cloud platform.

In October, **XOS** debuted the Petra Series Autosampler, an automatic sampler with sample tracking and continuous sample loading for XRF. The autosampler is an add-on feature to the Petra MAX and Petra 4294 HDXRF analyzers. It features sample tracking, continuous sample loading and customizable software features. The company also released a Gen 4 software upgrade for the Petra Series.

In November, **Agilent Technologies** introduced the Agilent ICP-MS Water Analyzer for environmental labs, representing an end-to-end workflow for analyzing water quality based on regulations established by the US EPA and the International Organization for Standardization. The offering includes the Agilent 7800 ICP-MS, browser-based ICP Go Software, and ICP implementation services.

Sales and Orders of Note

In October, **Whitehouse Labs**, a division of CRMO **AMRI**, announced the addition of an **Agilent Technologies** 7900 ICP-MS system for impurity testing of drug products and APIs.

AXT announced in October the installation of **Rigaku**'s MiniFlex XRD instrument at the **University of Sydney** in Australia's School of Chemistry in Australia.

Reported Financial Results

$USD in Millions	Period	Ended	Sales	Chg.	Op. Prof.	Chg.	Net Prof.	Chg.
AMETEK	Q3	30-Sep	$1.2	10.0%	$0.3	$0.2	$0.2	24.8%
AMETEK (Electronic Instruments)	Q3	30-Sep	$0.7	10.6%	$0.2	$0.2	NA	NA
Bionano Genomics	Q3	30-Sep	$2.8	3.1%	($6.0)	($5.0)	($4.9)	3.1%
Bio-Rad Laboratories	Q3	30-Sep	$545.1	2.1%	$36.3	$38.8	$269.3	$22.1
Bio-Rad Laboratories (Life Science)	Q3	30-Sep	$206.6	7.2%	$10.2	$5.3	NA	NA
Bruker	Q3	30-Sep	$466.6	7.1%	$69.1	34.7%	$43.4	17.3%
Bruker (BSI)	Q3	30-Sep	$417.1	6.8%	$63.6	42.9%	NA	NA
Bruker (BEST)	Q3	30-Sep	$50.9	10.4%	$5.4	200.0%	NA	NA
Fluidigm	Q3	30-Sep	$29.0	17.0%	($11.6)	25.5%	($14.8)	7.5%
Harvard Bioscience	Q3	30-Sep	$28.6	53.0%	$0.9	NM	($0.3)	60.3%
Illumina	Q3	30-Sep	$853.0	19.5%	$241.0	33.1%	$199.0	22.1%
Illinois Tool Works	Q3	30-Sep	$3,613.0	-0.1%	$889.0	-7.4%	$638.0	-0.3%
Luminex	Q3	30-Sep	$72.4	-2.3%	$40.5	3.1%	$1.7	-90.1%
Meridian Bioscience	FY	30-Sep	$53.1	6.8%	$25.0	14.7%	$7.1	-19.3%
Nanostring Technologies	Q3	30-Sep	$28.6	5.9%	($15.1)	-50.7%	($16.5)	NM
Pacific Biosciences	Q3	30-Sep	$18.2	-22.9%	($24.7)	-14.4%	($25.0)	-13.7%
PerkinElmer	Q3	30-Sep	$674.3	21.7%	$80.2	2.8%	$76.5	-16.0%
PerkinElmer (Discovery & Analytical Solutions)	Q3	30-Sep	$406.2	5.4%	$48.4	2.3%	NA	NA
PerkinElmer (Diagnostics)	Q3	30-Sep	$268.1	58.7%	$47.4	9.2%	NA	NA
Quanterix	Q3	30-Sep	$10.6	86.0%	($7.7)	-20.0%	($7.7)	-15.8%
Roper Technologies	Q3	30-Sep	$1,318.0	13.7%	$377.5	21.5%	$247.6	30.1%
Roper Technologies (Medical & Scientific Imaging)	Q3	30-Sep	$380.0	10.6%	$132.8	15.0%	NA	NA
Roper Technologies (Energy Sysems & Controls)	Q3	30-Sep	$148.8	10.0%	$46.3	27.2%	NA	NA
Other Currencies in Millions								
Biotage	Q3	30-Sep	SEK 232.2	31%	SEK 45.1	54%	SEK 43.3	44%
Expedion	Q3	30-Sep	€ 3.7	54%	€ 0.3	-59%	€ 0.5	-57%
HORIBA	Q3	30-Sep	¥146,030.0	10%	¥17,877.0	22%	¥13,473.0	25%
HORIBA (Scientific)	Q3	30-Sep	¥19,543.0	10%	-¥0.41	16%	NA	NA
HORIBA (Process & Environmental)	Q3	30-Sep	¥13,499.0	12%	¥1,182.00	279995%	NA	NA
Hitachi High-Technologies	Q2	30-Sep	¥3,631.0	8%	¥340.00	25%	¥246.00	22%
Hitachi High-Technologies (Science & Medical Systems)	Q2	30-Sep	¥983.0	12%	¥133.00	37%	NA	NA
Merck KGaA	Q3	30-Sep	€ 3,749.0	7%	€ 491.0	-43%	€ 340.0	-47%
Merck KGaA (Life Science)	Q3	30-Sep	€ 1,527.0	8%	€ 277.0	26%	NA	NA
Oxford Instruments	H1	30-Sep	£147.0	11%	£21.0	12%	£12.5	-37%
Oxford Instruments (Materials & Characterization)	H1	30-Sep	£60.1	20%	£9.7	35%	NA	NA
Oxford Instruments (Research & Discovery)	H1	30-Sep	£54.3	13%	£4.8	14%	NA	NA
Oxford Instruments (Service & Healthcare)	H1	30-Sep	£32.6	-4%	£6.5	-12%	NA	NA
Shimadzu	Q2	30-Sep	¥182.9	6%	£17.3	10%	¥12.92	14%
Shimadzu (Analytical & Measuring Instr.)	Q2	30-Sep	¥111.1	7%	£15.6	9%	NA	NA
Takara Bio (Bioindustry)	Q2	30-Sep	¥17,370.0	23%	£2,623.0	281%	¥1,720.0	470%

NA = not available, NM = not material