Strategic Directions International, Inc.

Instrument Business Outlook

Strategic Information for the Analytical & Life Science Instrument Industry

Instrument Business Outlook (ISSN 1061-2203) is published twice a month by Strategic Directions International, Inc.

Volume 26, Issue 1
April 15, 2017

IBO's Top 30 Companies of 2016

IBO's 2016 list of the top 30 analytical and life science instrument, aftermarket and lab product companies experienced a dramatic rearrangement for first time in a number of years due to acquisitions, as well as organic revenue growth and currency implications. The most notable changes included the addition of two new companies to the Top 30 list, Rikagu and Promega, as well as the return of HORIBA, which last made the list in 2013 (see ***IBO*** 4/15/14). Furthermore, consolidation and sales performance resulted in significant reshuffling amongst the top 10

firms.

Top 30 Analytical and Life Science Instrument, Aftermarket and Lab Product Firms of 2016		
Rank	**Company**	**CY Rev. ($M)**
1	Thermo Fisher Scientific	$7,298
2	Agilent Technologies	$3,690
3	Danaher	$3,305
4	Illumina	$2,188
5	Waters	$2,165
6	Merck KGaA	$1,676
7	Shimadzu	$1,526
8	PerkinElmer	$1,500
9	Bruker	$1,438
10	GE	$1,050
11	QIAGEN	$998
12	Becton, Dickinson	$979
13	Bio-Rad Laboratories	$761
14	Mettler-Toledo	$715
15	Zeiss	$712
16	Hitachi High-Technologies	$642
17	JEOL	$575
18	Nikon	$547
19	Roche	$526
20	AMETEK	$520
21	Spectris	$506
22	Eppendorf	$496
23	Sartorius	$457
24	Olympus	$429
25	Oxford Instruments	$427
26	VWR	$402
27	HORIBA	$308
28	Rigaku	$288
29	Tecan	$283
30	Promega	$275

Overall, total sales growth for the top 30 companies was healthy in 2016, climbing 3.5% excluding acquisitions, or 4.1% organically, to $36.7 billion to account for 70% of total industry sales (see ***IBO*** 1/15/17). Growth was driven by

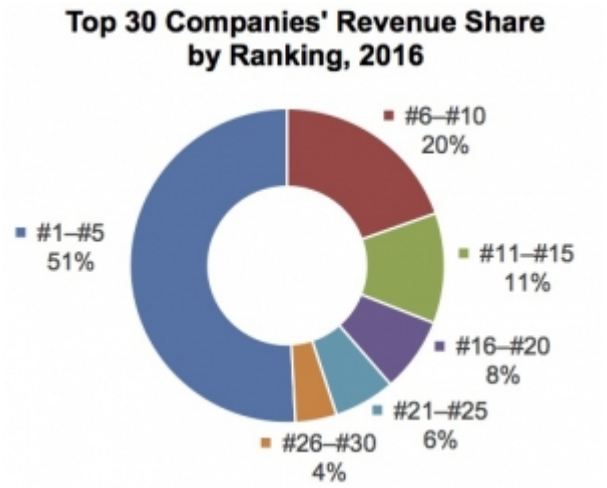
strong biopharmaceutical demand, especially for LC, MS, automation and NGS products, including particular strength in China. However, similar to the previous year, demand was hindered by challenges in the core industrial and chemical markets, as well softness in Japan. European academic demand also slowed for a number of companies in the Top 30 list in the second half of 2016.

All sales and revenue growth figures in this article are based on ***IBO***'s calculations of companies' calendar year revenues that fall into the 10 technology categories in ***IBO***'s forecast issue (see ***IBO*** 1/15/17). Recalculations of sales based on updated technology categories and new financial information have also altered rankings compared to ***IBO***'s 2015 Top 30 list (see ***IBO*** 4/15/16).

Products excluded from ***IBO***'s Top 30 list include process instruments, special-purpose clinical diagnostics products with regulatory approval and OEM sales.

All sales have been converted into US dollars. Exchange rates for foreign companies when converted into US dollars also impacted estimated revenues and rankings. Compared to 2015, sales for the seven Japanese companies benefited from the weakening of the US dollar, while the two UK-based firms were negatively impacted by the devaluation of the British pound when converted into US dollars. There was no material impact for the five companies reporting in euros.

While the total industry remains relatively fragmented, the market share for the largest vendors continues to climb. In 2016, sales for the top 10 companies advanced roughly 10% to $25.8 billion due to acquisitions and strength in the biopharmaceutical end-markets. As a percentage of the total industry, sales for the top 10 companies accounted for 49% in 2016, compared to 46% in 2015 as adjusted for this issue.



Consolidation continues to play an integral role in the expansion of sales and market share for a number of the largest companies in the Top 30 list. Thermo Fisher Scientific extended its number 1 position in 2016 through the acquisition of Affymetrix (see ***IBO*** 1/15/16) and partial sales integration of FEI (see ***IBO*** 5/31/16). The company's share of total industry revenue rose roughly 90 basis points to 14%, nearly double its closest rival, Agilent Technologies.

Acquisitions also elevated Merck KGaA into the list of top 10 companies. Following the full inclusion of Sigma-Aldrich (see ***IBO*** 11/30/15), Merck KGaA jumped six positions into the number 6 spot and substantially expanded its chromatography and lab equipment market shares.

Other notable changes among the rankings of the top 10 companies included Illumina's rise to the number 4 spot. Since its initial debut on the list of Top 30 companies in 2008 (see ***IBO*** 4/15/09), Illumina has catapulted to the top of the list through the development of disruptive technologies and fast market adoption of its high-throughput NGS systems. However, the company experienced more normalized growth in 2016 due to slower demand for its HiSeq X systems. Illumina is also one of the only companies in the list of top 30 companies with a notable consumer end-market.

Despite losing ground to Illumina, Waters recorded a strong financial year in 2016 as sales benefited from its leadership position in the high-end LC market. The company has been successful in expanding existing technologies into adjacent markets, especially in applied markets, as well as for QA/QC applications.

Like Waters, Shimadzu experienced strong demand for LC and MS products in 2016 and was further boosted by the conversion to US dollars. As a result, the company climbed one spot to number 7. Conversely, both PerkinElmer and Bruker slipped two spots to number 8 and 9, respectively, due to continued challenges in industrial and academic markets.

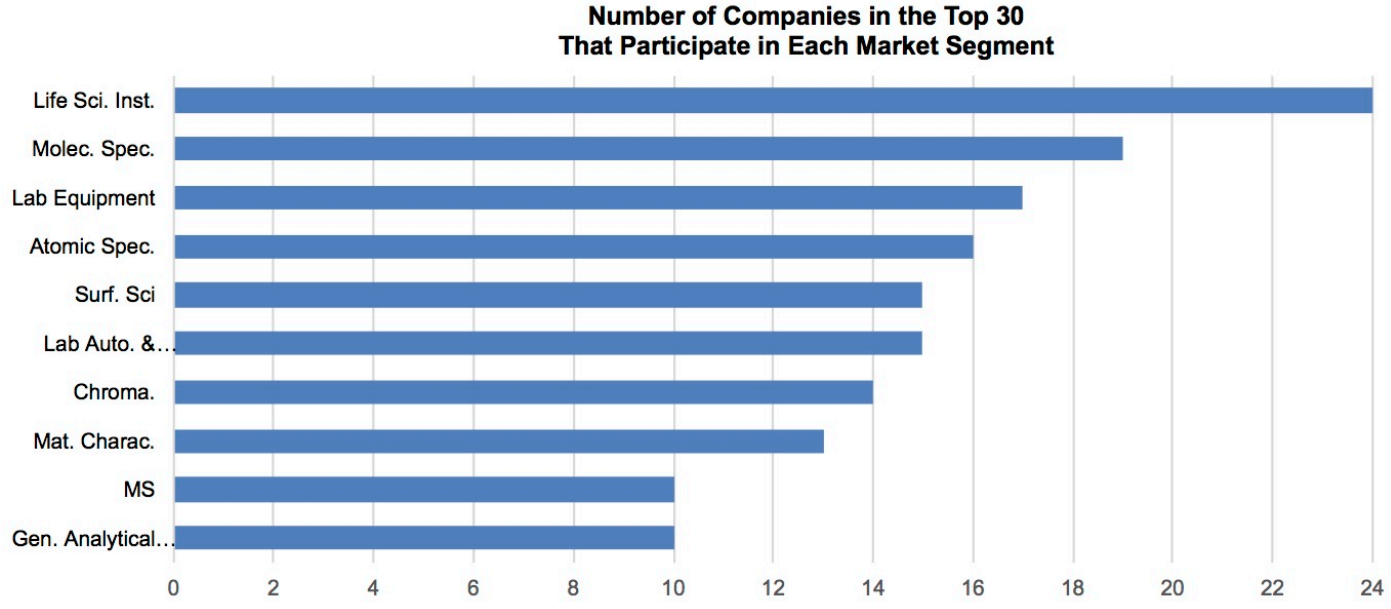
Outside of the top 10 companies there were only a few notable changes. AMETEK advanced three positions to number 20 as the company benefited from partial integration of Brookfield Engineering Laboratories (see ***IBO*** 2/15/16) and Nu Instruments (see ***IBO*** 8/15/16). These acquisitions helped offset lower demand for the company's surface science business.

Sartorius similarly climbed three spots, landing in the number 23 position. Sales growth for the company advanced due to strong demand for lab filters and bioreactors.

Like AMETEK, most other vendors in the surface science market, including JEOL, Nikon, Olympus, Oxford Instruments and Zeiss, either declined one spot or lost ground when excluding favorable currency impacts due to slowing demand.

The two new additions to this year's Top 30 list benefited from the removal of Affymetrix, FEI and Sigma-Aldrich, but also from stronger demand. Rigaku, which debuts at number 28, gained a spot due to a stronger global footprint, currency conversion and the acquisition of Agilent's XRD business (see ***IBO*** 3/31/15). Promega, which was the last addition at number 30, recorded stronger demand for PCR and nucleic acid preparation products.

As the graph below shows, most Top 30 companies participate in more than one of the 10 market segments that ***IBO***'s forecast issue covers. Due to the breadth of life science instruments and aftermarket products, it is the largest technology category for Top 30 companies, with 24 companies selling into that market. Molecular spectroscopy's multiple applications and use in both research and QA/QC put it in the number 2 spot. Although MS is a powerhouse market segment for the top 30's largest companies, it is a market segment for which participation is relatively narrow among the top 30 in general.



Although Thermo Fisher would seemingly be the broadest based company, Danaher also offers products in 10 market segments. However, participation in multiple technology segments does not automatically correlate with a higher ranking. Number 4 Illumina participates in only two market segments, as does Becton, Dickinson, Nikon, Roche and Zeiss.

African Countries on Fast Track to Improve Scientific Innovation

There are many opportunities for growth in Science, Technology and Innovation (STI) in African countries, but due to gaps in capacity in infrastructure, workforce and training, and investment, STI has not flourished as predicted within the last decade. The "Africa Capacity Report 2017," released last month by the African Capacity Building Foundation, examines the STI policies and initiatives African countries have established and how they can be improved.

The Report focuses on finding the frameworks needed to better improve STI in Africa by closing capacity gaps in the field, as STI is seen as a critical factor of economic development across the continent. Capacity is defined as the "ability of people, organizations and society as a whole to manage their affairs successfully; and capacity development as the process by which people, organizations and society as a whole unleash, strengthen, create, adapt and maintain capacity over time."

In June 2014, heads of states and governments in Africa adopted a 10-year Science, Technology and Innovation Strategy for Africa to accelerate scientific R&D and innovation throughout the continent. STI is seen as a key factor for improving the sustainability of economies for many African countries. Although in 1980 and 2005, African countries pledged for R&D expenditure to reach 1% of the countries' GDP, currently, the average African R&D expenditure is 0.5% of GDP.

Many STI institutions across the continent lack proficient workforces, financial means, infrastructure and equipment to effectively promote and develop STI. Ninety-one percent of the 44 countries surveyed for the Report indicated that training in STI is a High or Very High priority. Other High or Very High priorities include infrastructures for information and communications technology (80%), investment (75%), publication of scientific papers (72%), policy and strategy (70%), and laws and regulations (65%).

The African Capacity Index is a composite index based on four sub-indices on policy environments, processes for implementation, development results in each country and outcomes of capacity development. No country in Africa is at Very Low or Very High capacity levels, as 75% of countries have Medium Capacity, 21% are at High Capacity and 5% are in the Low capacity level. Only 7% of countries ranked as Very High for capacity development, which is a key issue in the Report.

Overall, the capacity score increased 13.7% in 2016 from the year before to 59.1. According to results in the Report, African countries show great policy environments and implementation policies but capacity development remains an issue, as many countries do not have adequate resources for capacity building. Morocco is the highest ranking country in the Index, with excellent results for policy environment, and processes for implementation and development results in the country. Malawi had lost its ranking in the top 10 in 2015, but made a comeback to ninth place in 2016.

Top 10 Countries in Africa Capacity Index (ACI), 2016

Rank	Country	ACI 2016 Value
1	Morocco	71.6
2	Tanzania	68.8
3	Rwanda	68.2
4	Mauritius	67.3
5	Cabo Verde	62.6
6	Tunisia	62.6
7	Gambia	61.7
8	Mali	61
9	Malawi	60.7
10	Burkina Faso	58.8

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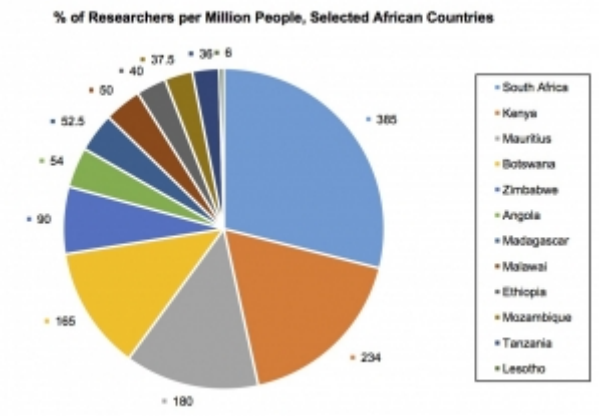
Although they have good policy environments, the Central African Republic and Swaziland are amongst the lowest ranking countries due to their poor performance in implementation and development results in the country. The Report indicates that more effective policies are required for these countries to move up in rank.

Gross domestic expenditure for R&D (GERD) for countries in West Africa rose to 0.3% of GDP in 2016, with Mali leading at 0.66% of GDP. Government funding is the main source of GERD, but foreign investments also play a large part in some countries. In Ghana, for example, 31% of GERD comes from foreign sources, 41% in Senegal and 60% in Burkina Faso. In Gambia, almost 50% of its GERD comes from private and nonprofit sources.

In North Africa, GERD is, on average, higher than in Sub-Saharan Africa. Morocco, the leader of the Index in 2016, had a GERD of 0.79% in 2015. South Africa R&D has greatly declined since 2008 despite its rising public expenditure on R&D. Overall, GERD increased the most in Ethiopia and Morocco, with the government serving as the primary investor in R&D.

A major impediment in STI capacity development is the shortage of researchers in many African countries. Many countries have improved their STI education systems, as well as education policies for technology transfers, and this has led to small improvements in human capital.



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Lack of infrastructure, small numbers of researchers and minimal scientific output due to low investments in STI has affected the acceleration of scientific innovation in Africa. The Report indicates that STI capacity building can be greatly improved if African countries increase the number of researchers. The majority of countries had less than 300 researchers per million citizens in 2013 (or the closest year that data were available). Tunisia had the greatest number of researchers in 2013, with 1,394 full-time researchers per million people, with Morocco following at 864.

The Report recommends that governments of African countries must seriously commit to establishing top-tier academic institutions and labs by developing better investment and research funding mechanisms. Additionally, regional communities dedicated to improving the economies of their countries, such as the Economic Community of West African States and the Southern Africa Development Community, need to create a better link between regional and national STI systems for a more harmonious and cohesive flow of standards and regulations for STI R&D.

The Report posits that building STI capacity is a major factor in transforming the African economy as a whole, including food security, diminishing poverty, creating jobs, and providing access to energy technologies and health care. Since the majority of African countries rank in the Medium or High sectors, the outlook for STI growth is promising; however, a lack of researchers and human capital, infrastructure and investments in STI is stagnating progress. Because of this, the Report suggests that better integration between regional and national STI frameworks is needed to improve integration and coordination between existing STI initiatives and policies.

Government and business sectors are also recommended to come together to provide better financial investments into STI to promote exchange programs, improve human resources and accelerate innovation in private companies. All African countries are recommended to focus more investments on capacity development in order to transform Africa into an STI hub, consequently improving their economies.

Funding Table

Selected New R&D and R&D-Related Funding Announcements			
Funder	**Recipient**	**Amount**	**Project**
LG Chem	LG Chem R&D	KRW 1 trillion ($895 million)	This is a 14.8% increase according to PulseNews and amounts for 4% of 2016 revenues. Thirty percent of the total will go toward batteries and advanced materials for vehicles, according to BusinessKorea, which also reports that the LG Chem plans for total R&D spending of $1.25 billion by 2020.
Federal Ministry of Education and Research (BMBF), Germany	13 Facilities	€400 million ($444 million)	The "Research Factory Microelectronics Germany" will comprise a network of research sites for microelectoronics R&D. In total, the Fraunhofer Association for Microelectronics and the Ferdinand Braun Institute, the Leibniz Institute for High Frequency Technology and the Leibniz Institute for Innovative Microelectronoics will receive €350 million ($389 million). The remaining funding will go distributed to other universities starting in 2018. Four technology parks will focus on new silicon technologies, semiconductors with advanced materials, silicon and other semiconductors for the Internet of Things, and reliability.
EU	Horizon 2020	€200 million ($222 million)	Under a preliminary budget agreement, expected to be formalized within weeks, the EU's Horizon 2020 research program will receive additional €200 million in funding. The funding consists of: €50 million ($56 million) for the European Research Council; €55 million ($61 million) for Spreading Excellence and Widening Participation; €50 million ($56 million) for the European Innovation Council and €45 million ($50 million) for High Performance Computers.
The Bezos Family	Fred Hutchinson Cancer Research Center	$35 million	Announced in March, the funding will go towards the areas of translational data science, pathogen-related cancers and transplantation and immunotherapy. This is the largest donation in the Center's history.
Jerold B. Katz Foundation	Houston Methodist Research Institute	$21 million	The funding, announced in March, will go towards establishing the Jerold B. Katz Academy of Translational Research ($12 million), which will have eight endowed reseachers; forming the Translational Research Initiative II fund ($5 million); and funding the Jerold B. Katz Translational Research Infrastructure Fund for lab equipment ($4 million), and collaborative projects between researchers and clinicians ($5 million).

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AACR 2017: New Products for Cell Analysis

The 108th annual American Association for Cancer Research (AACR) meeting was held April 1–5 in Washington, DC. The conference had record attendance of 21,900 registrants. The total number of exhibitors was 497.

The exhibit was a showcase for several new products, in particular, products for NGS. 10x Genomics launched the **Chromium Single Cell V(D)J Solution** for profiling full-length paired V(D)J transcripts from hundreds to millions of lymphocytes. (From nature.com, “VDJ recombination is the process by which T cells and B cells randomly assemble different gene segments—known as variable (V), diversity (D) and joining (J) genes—in order to generate unique receptors [known as antigen receptors] that can collectively recognize many different types of molecule.”) Antigen specificity is thus determined by two co-expressed genes, the heavy and light chains of the B-cell receptor, and the alpha and beta chains of the T-cell receptor.

This is the 10x’s second reagent system for single-cell analysis. The company chose this application because the ability to more completely identify and characterize T and B cells by single-cell sequencing will reveal the true clonality and diversity of the adaptive immune system; thus, lending insight into a wide range of applications, including the development of immune-oncology drugs for targeted cancer therapy. The reagent system for T-cell analysis is available now; the reagents for B-cell analysis should be released later this year. Lymphocytes, Peripheral Blood Mononuclear Cells (PBMCs), cell lines, FACS-isolated cells and MACS MicroBead-enriched cells can all be analyzed using these reagents. The per cell price is 12.5¢ when 10,000 cells are run on one channel, and 25¢ when 5,000 cells are run on one channel.

For its single-cell assays, 10x introduced the Chromium Single Cell Controller in 2016, which has a current list price of $75,000. The Chromium Controller for both single-cell solutions and linked-read technology for genomics is $125,000. According to Brian R. Fritz, PhD, Senior Product Manager, Single Cell Genomics, the system is priced to be attractive to core labs. Using the Controller, 100 to more than 10,000 cells can be partitioned per channel in less than 7 minutes; 1–8 channels can be run in parallel. Key to meaningful single-cell analysis is the low doublet rate of only 0.9% per 1,000 cells.

The Chromium Single Cell V(D)J Solution workflow is fast: Cells are partitioned and bar-coded in less than 7 minutes. Reverse transcription takes 1 hour and then the encapsulated cells are disrupted. 5’-barcoding eliminates the bias that can come from multiplexed PCR, and enables the detection of germline and somatic variants across the

entire V(D)J segment. A UMI (Unique Molecular Identifier) enables quantification. NGS library preparation takes about eight hours, and then the samples are ready for sequencing on an Illumina HiSeq 4000/2500, NextSeq or MiSeq sequencer.

The comprehensive solution also includes a complete software suite for the rapid analysis and visualization of large V(D)J datasets, designed for researchers without bioinformatics expertise. The Cell Ranger pipeline leverages barcoding to perform gene expression analysis with scalable single-cell resolution. The Loupe for Cells visualization application features powerful but easy-to-use clustering and differential expression analysis.

Also for the single-cell sequencing market, Illumina and Bio-Rad Laboratories promoted their recently introduced joint product, the **Illumina Bio-Rad Single Cell Sequencing Solution**. Designed to create a robust, scalable and user friendly workflow, the system was co-developed by Bio-Rad with Illumina, leveraging Bio-Rad's expertise in Droplet Digital technology paired with the **Illumina SureCell WTA 3' Library Prep Kit**. Up to 4 biological samples can be processed in less than 5 minutes.

The solution includes the **ddSEQ Single-Cell Isolator**, manufactured and shipped by Bio-Rad. The ddSEQ Single-Cell Isolator can encapsulate hundreds to thousands of cells per sample. Stable and uniform droplets are generated for robust cell lysis, combined with efficient barcoding and first strand cDNA synthesis. Second strand synthesis is performed, followed by library preparation without shearing or pre-amplification, using Illumina's Nextera tagmentation technology. The total workflow from cell encapsulation to sequencing is about two working days. Prepared single-cell libraries can be loaded directly onto an Illumina MiSeq, NextSeq or HiSeq Series System for sequencing. Data analysis is streamlined and simplified using Illumina's single-cell-analysis BaseSpace App.

According to Leanne Huysentruyt, PhD, Digital Biology Product Manager, Americas, for Bio-Rad, the co-developed system was launched on February 10. The ddSEQ Single-Cell Isolator is priced at approximately $60,000. The list price for the 2-cartridge SureCell WTA 3' Library Prep Kit is $2,500; the 6-cartridge kit lists for $7,200. The system directly competes with the 10x Chromium System, but there are some differences in workflow and scale; the Illumina Bio-Rad single-cell solution is designed for "smaller-scale" single-cell experiments that range from hundreds to thousands of cells from each biological specimen.

The show was also a debut for **Beckman Coulter Life Sciences' CytoFLEX LX flow cytometer**, which began shipping in February 2017. The latest in the company's series of benchtop CytoFLEX systems, it can measure up to 23 parameters, the highest number among the CytoFLEX series When the system is shipped, all 6 lasers are installed. The customer can "customize" which lasers are activated. If, at a later time, the customer wants additional capacity, then the laser can be activated using system-specific software.

The system's use of avalanche photondiodes, not PMTs, to detect the light enables better sensitivity, according to Neil Kayal, PhD, Account Sales Consultant, US North Atlantic Region, Research Flow Cytometry. He told ***IBO*** that the use of highly multiplexed flow cytometry is of great interest in the fields of immunology and immuno-oncology. Beckman Coulter expects this system to be especially useful to researchers in pharma/biotech since so many biomarkers can be screened for simultaneously. With all 6 lasers activated (21 colors), the system price is $350,000. With 5 lasers activated (19 colors), the price is $300,000.

Bio-Rad Laboratories' ZE5 Cell Analyzer was on display at AACR. The product is scheduled to begin shipping on April 15, priced at $550,000 fully loaded. About 20 systems were placed in 2016 during an early adopter program. The ZE5 is Bio-Rad's first flow analyzer. As Matthew Goff, Senior Cell Biology Systems Specialist, told ***IBO***, the company got into flow cytometry because they saw it as an upstream need to support its investment in Droplet Digital technology. The system features solid state lasers, on-board fluidics and QC beads, and is an open platform. The universal loader can handle 96-well plates, 384-well plates, single tubes or a rack of tubes. A 96-well plate, 10 µl sample/well run takes 10 minutes. According to Bio-Rad, the ZE5 is designed for flow core lab users. Bio-Rad started with a punch list of what really bothered power users of flow cytometry and then designed an instrument that solved them. Target markets also include pharma/biotech labs as well as pharma ADME/Tox labs.

MilliporeSigma previewed its **SMCxPRO** platform and kits at the show. The product is the result of MilliporeSigma's acquisition of exclusive rights to Singulex's SMC (Single Molecule Counting) technology two years ago (see ***IBO*** 5/31/15). Compared to other digital counting systems, such as the Quanterix Simoa HD-1 Analyzer, the SMCxPRO is a compact benchtop system, according to Danielle Pepin, Product Manager, Immunoassay Protein Solutions. The SMC technology is ideal for protein targets that occur at very low levels. The current range of catalog assays is focused on cytokines, key growth factors and specific neuroassays. Researchers can develop their own assays using

SMC immunoassay and optimization kits, or work with the MilliporeSigma custom services team to develop bespoke SMC immunoassay kits. The system is scheduled to be released in the second half of the year at a lower price than Singulex's Erenna Immunoassay System.

Next year's AACR meeting will be held April 14–18 in Chicago, Illinois.

Sartorius Buys Process Software Firm

Göettingen, German 4/3/17; Andover, MA 4/3/17—Sartorius, a provider of pharmaceutical and lab equipment, has acquired Sweden-based MKS Data Analytics Solutions (formerly Umetrics) from MKS Instruments for $72.5 million in cash. MKS Data Analytics Solutions supplies Multivariate Data Analysis (MVDA) and modeling software. In 2016, MKS Data Analytics Solutions recorded revenues of $13 million. Sartorius estimates the company's 2017 sales will be $15 million and that it will generate a double-digit operating profit margin. The companies have worked together for around five years.

MKS Data Analytics offers software for DoE (Design of Experiment) and MVDA for a number of industries. Sartorius Stedim Biotech (SSB) entered into a sales partnership with Umetrics in 2012, under which SSB marketed and distributed Umetrics' products for the pharmaceutical and biopharmaceutical industries. As part of this agreement, SSB offers the BioPAT platform for bioprocess. Bioprocess applications of MVDA include cell culture processes and batch-to-batch comparisons.

Porvair Sciences Adds US Base

Wales, UK 45/17—Specialist filtration and environmental technology provider Porvair has acquired J. G. Finneran (JGF) for $8.0 million in cash and a deferred cash payment of up to $6.0 million. JGF designs, manufactures and distributes specialist lab consumables, such as filters, vials, microplates and closures. The business will join Porvair's Porvair Sciences business, a manufacturer of ultra-clean microplates and supplier of consumables. Porvair Sciences stated that the acquisition will expand its glass, plastics and assembly manufacturing capabilities, and its US distribution. Porvair Sciences also commented that the JGF product lines complement Porvair's biotechnology and chromatography product lines. The acquisition is expected to be earnings enhancing.

JGF has 110 employees, according to a JGF spokesperson. She told IBO, "Finneran brings to Porvair the manufacturing and distribution capabilities in the chromatography, biotechnology and environmental industries. We manufacture and distribute, through a global dealership network, the vials, seals, limited volume inserts, and closures for most of the analytical autosamplers used in labs performing chromatographic analyses. We also offer a patented 96-well microplate system that works in conjunction with the 96-well microplates offered by Porvair. For the environmental testing industry, Finneran manufactures and distributes vials, bottles and jars used for water and soil sample collection."

Porvair Sciences is one of three business that make up publicly held Porvair's Microfiltration division (the other two are Porvair Filtration Group and Seal Analytical). In fiscal 2016, Porvair recorded revenues of £74.6 million ($100.8 million = £0.74 = $1), of which 20% was laboratory supplies.

VWR Invests in Clinical Trial Services

Radnor, PA 4/7/17—VWR, a supplier of product and service solutions to lab and production customers, has acquired UK MESM for an undisclosed amount. MESM provides lab and medical equipment, and ancillary supplies for clinical trials, including standard and non-standard products. "MESM is recognized and valued by many of the world's largest pharmaceutical customers and contract research organizations, including a number of existing VWR

customers who currently procure our clinical trial and biorepository services," stated VWR President and CEO Manuel Brocke-Benz. "Their focus on equipment supply and excellence in supply chain further complements VWR's growing service offering as a part of VWRCATALYST, allowing us to better serve our customers in achieving their goals by providing end-to-end product and supply chain solutions." MESM is headquartered in the UK with a facility in the US.

*This is VWR's third acquisition this year (see **IBO** 1/15/17, 3/31/17), including the second purchase of a service biopharma service provider. According to VWR, MESM's services include equipment sourcing, technical advice and product training, logistics services, in-study equipment servicing and technical support, and end-of-study equipment reporting, decommissioning and removal.*

LGC Invests in Therapeutic Nucleic Acids

London, UK 4/3/17—Life science measurement and testing firm LGC has purchased Germany-based Axolabs, a contract research, development and manufacturing organization that specializes in Therapeutic Nucleic Acid (TNA) development. Axolab has 60 employees. "Axolabs' in-depth know-how in the TNA drug development field complements LGC's capabilities in GMP oligo manufacture, CMC [Chemistry, Manufacturing, and Control] analytical and bioanalytical services, and we look forward to working together with the Axolabs team and its customers," said Dr. David Griffiths, managing director of LGC's Laboratory & Managed Services division.

*The acquisition further expands LGC's oligo-related offerings for therapeutic applications, which include its 2016 purchase of Prime Synthesis (see **IBO** 11/30/16). Axolabs' capabilities include in-silico design, synthesis, analytics, bioanalytics, biology, pharmacology and consulting services.*

Fourth Quarter 2016 and FY16 Results: Bio-Rad Laboratories, Biotage, Danaher, Fluidigm, HORIBA, NanoString Technologies, Pacific Biosciences, Tecan

CY Q4 2016 Results								
	Revenues			Rev. Growth Summary			Adj. Operating Profit	
Company	Rev. (M)	% of Co. Rev.	Growth	Curr.	Acq./Div.	Org. Growth	(M)	% Growth
Bio-Rad Laboratories (Life Science)	$206.8	36%	-5.2%	-1%	0%	-4%	NA	NA
Biotage	SEK 179.1	100%	6.3%	5%	0%	1%	SEK 24.0	12.8%
Danaher	$4,584.3	100%	6.0%	-2%	4%	4%	$728.6	11.8%
Fluidigm	$25.1	100%	-18.4%	NA	0%	-18%	-$14.8	-36.0%
HORIBA (P&E, SI)	¥12,552.0	24%	1.9%	-8%	0%	10%	¥1,259.0	9.5%
NanoString Technologies	$25.2	100%	13.1%	NA	0%	13%	-$9.9	-30.2%
Pacific Biosciences	$25.7	100%	-29.1%	NA	0%	-29%	-$17.9	-1583.1%
Tecan (Life Sciences) (H2)	CHF 162.5	60%	11.7%	1%	3%	8%	CHF 33.5	-1.7%

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Timing Curbs Bio-Rad LS Growth

Q4 2016

Fourth quarter 2016 sales for Bio-Rad Laboratories' Life Science (LS) segment declined 5.2%, 4.3% excluding currency, to $206.8 million to account for 36% of revenues. The expected decline was due to completed backlog orders and timing of process media sales in the previous year. However, this decline was partially offset by higher sales of Droplet Digital PCR and food safety products. Given the strong comparison, LS sales declined in most geographic regions, including China. Reported LS operating loss widened dramatically to $19.2 million but included

substantial restructuring, impairment and other one-time charges.

2016

Full-year 2016 LS sales grew 5.1%, 6.5% excluding currency, to a record $730.7 million to account for 35% of revenues. Sales were strong for Droplet Digital PCR and process media products, and grew steadily for gene expression, Western Blot reagents and food safety products. Geographically, currency-neutral sales grew in all regions, led by North America and Asia Pacific, especially China. Despite plans to release a new product related to the acquisition of GnuBIO (see ***IBO*** 4/15/14), the company recorded impairment and in-process R&D charges of $59.9 million due to the delayed R&D development. For 2017, LS sales are projected to grow 4.5%–5.0%. The acquisition of RainDance Technologies (see ***IBO*** 2/15/17) is estimated to add $20 million in sales.

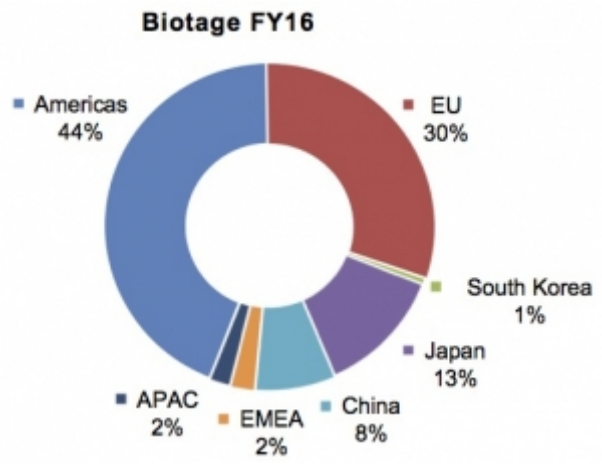
Biotage Q4 2016 Organic Growth Slows

Q4 2016

Boosted by currency, fourth quarter 2016 sales for Biotage advanced 6.3% to SEK 179.1 million ($19.8 million = SEK 9.05 = $1). However, sales growth was limited to 0.9% excluding currency. Operating margin expanded 140 basis points to 13.4%.

2016

Full-year 2016 sales climbed 9.4%, 7.8% excluding currency, to SEK 667.9 ($78.0 million at SEK 8.56 = $1). Growth was driven by Organic Chemistry sales, which benefited from healthy uptake of the new V-10 Touch evaporation system. Stronger-than-expected sales for the purification system Isolera also contributed to this growth. Consumables sales within the Analytical Chemistry business remained positive, driven by strong growth in the US. Geographically, sales in China were accentuated, climbing 28% due to strong system revenues.



Click to enlarge

Biopharma Markets Lift Danaher Sales

Q4 2016

Fourth quarter 2016 sales for Danaher's Life Sciences segment expanded 5.8%, 4% organically, to account for 32% of company revenues. Segment growth was driven by demand for MS products from biopharmaceutical customers, especially in China and India. As such, sales for the SCIEX business grew in the mid-single digits organically. Strong service revenues, which climbed double digits, as well as healthy demand from food and environmental markets, further contributed to SCIEX growth. Geographically, SCIEX sales advanced at a sturdy pace in both China and Western Europe.

Sales for the Beckman Coulter Life Sciences (BCLS) business grew in the low single digits organically, driven by demand for flow cytometry and particle counting products. Sales for the CytoFLEX system maintained strength, helping deliver higher BCLS sales growth in North America. BCLS sales in China delivered another quarter of double-digit sales growth, but were partially offset by lower demand in Latin America.

Despite weakness in Japan, Leica Microsystems sales grew in the low single digits organically, driven by demand in North America and China.

Sales for the acquired Pall business (see ***IBO*** 5/15/15) grew in the mid-single digits organically, driven by demand for single-use technologies within Pall Life Sciences. Meanwhile, Pall Industrial sales improved in the low single digits, as higher demand from microelectronics and aerospace markets was partially offset by weakness in the Process Technologies business.

Fourth quarter sales for Danaher's Environmental & Applied Solutions segment grew 3.5%, 4% organically, to $959.1 million to make up 21% of revenues. Sales for the water quality platforms grew in the low single digits organically. Hach sales improved in the low single digits organically, as demand from municipal and industrial customers in the US offset lower project activity in Eastern Europe and China. However, Hach orders grew at a faster pace, rising in the mid-single digits due to improved bookings in the US and Western Europe.

2016

Full-year 2016 sales for the Danaher's Life Sciences segment advanced 3.5% organically to $5.37 billion to make up 32% of company revenues. Organic MS sales grew roughly in the mid-single digits, led by demand from biopharmaceutical customers and strong services revenues. However, this growth was partially hampered by weakness in Japan and slower demand from clinical customers in North America. Microscopy sales were flat, while sales of flow cytometry and particle counting products improved in the low single digits. Pall Life Sciences sales benefited from higher demand for single-use technologies in bioproduction.

Full-year Environmental & Applied Solutions grew 3% organically to $3.69 billion to make up 22% of revenues. Price increases contributed 1.0% to organic sales growth. Sales in the water quality businesses grew at a low single-digit pace as in the fourth quarter 2016.

Danaher Q4 2016					
	Rev. ($M)	Rev. Growth	Curr.	Acq.	Org. Growth
Life Sciences	$1,454.1	5.8%	-1.0%	3.0%	4%
Environmental & Applied Solutions	$959.1	3.5%	-1.5%	1.0%	4%

Click to enlarge

Fluidigm Closes Out Disappointing Year

Q4 2016

Fourth quarter 2016 sales for Fluidigm fell 18.4% to $25.1 million due to weak instrumentation demand across most platforms and lower consumables sales. Like third quarter 2016, sales growth was negatively impacted by competitive challenges and weak academic demand, especially in Europe.

Notwithstanding the sharp year-over-year decline, sales stabilized from the previous quarter, advancing 13.0% on a sequential basis. In addition, the company noted increased interest for mass cytometry products from biopharmaceutical customers, sustained demand in China and strong Service revenue, which climbed 25.9%.

Product sales tumbled 23.7% to account for 84% of revenues. Genomics and mass cytometry–related sales declined 26.3% and 19.6% to make up 59% and 41% of Product revenue, respectively. Instrument demand was particularly weak for Helios and, to a lesser extent, the sample preparation C1 system. However, the company reported positive interest in the new imaging mass cytometry system, which was released on a limited basis towards the end of the

quarter. Consumables revenue also contracted, as higher sales of mass cytometry products, which grew 33%, were more than offset by lower demand for Integrated Fluidic Circuits (IFCs). Sequentially, instrument and consumables sales advanced 16% each due to increased demand for mass cytometry products.

Geographically, sales in the US, Europe and Other regions contracted 4%, 37% and 79% to make up 52%, 27% and 1% of revenues, respectively. Accounting for 19% of revenues, sales in Asia-Pacific climbed 8%, including 77% growth in China.

Adjusted Product gross margin contracted 278 basis points to 65.5% due to product mix and lower production volume. Adjusted operating loss widened 36.0% to $14.8 million.

2016

Full-year 2016 sales contracted 8.9% to $104.4 million, driven by a significant decline in genomic instrumentation sales in the second half of the year, as well as lower consumables utilization. Alternatively, Service revenue grew 23.5%.

Product revenue sank 12.9% to account for 85% of sales. This decline was primarily attributed to lower demand for C1 and Access Array products. As a result, genomics sales fell 19.3% to account for 68% of Product revenue. Accounting for 32% of Product revenue, mass cytometry sales improved 4.7%, including a 40% increase in consumables revenue.

Following an internal business review, the company modified its list of installed systems, excluding units sold past an 18-month period for which no consumables purchases were recorded. As a result, the company's active installed base was reduced by 515 systems to roughly 1,340. A majority of those inactive systems were Access Arrays platforms, as customers transitioned to the Juno system.

The decline in C1 systems mostly impacted sales in Europe, which declined 19.1%. Sales in the US and Other region contracted 5.0% and 35.5%, respectively. However, sales in Asia-Pacific advanced 8.9%, as strength in China offset lower Japanese sales.

Adjusted Product gross margin dove 247 basis points to 66.4%. Adjusted operating loss widened 44.5% to $61.9 million. The company initiated cost saving measures, including headcount reductions in the first quarter, which is expected to lower operating expenses by $8 million in 2017. First quarter sales are expected to be stable, representing flat growth on a sequential basis but a decline of roughly 13% year over year.

Fluidigm FY16						
	Q4			FY		
	Rev. ($M)	% of Rev.	Rev. Growth	Rev. ($M)	% of Rev.	Rev. Growth
Instruments	$10.7	42%	-32.1%	$46.8	45%	-19.9%
Consumables	$10.3	41%	-12.3%	$42.2	40%	-3.5%
Service	$4.1	16%	25.9%	$15.2	15%	23.5%
License & Grants	$0.1	0%	-5.1%	$0.2	0%	-7.4%

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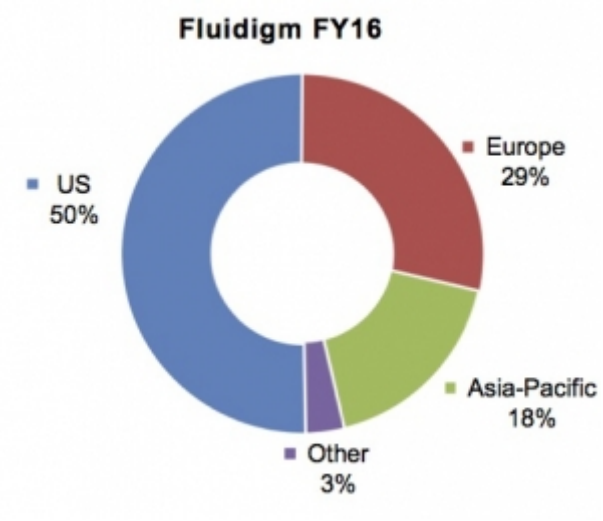

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HORIBA Ends Year on a High Note

Q4 2016

Fourth quarter 2016 sales for HORIBA's Process and Environmental Instruments & Systems (P&E) sales expanded 2.9%, roughly 9% excluding currency, to ¥4.94 billion ($45.2 million at ¥ 109.46 = $1). Growth was led by higher sales of stack-gas analyzers in Asia.

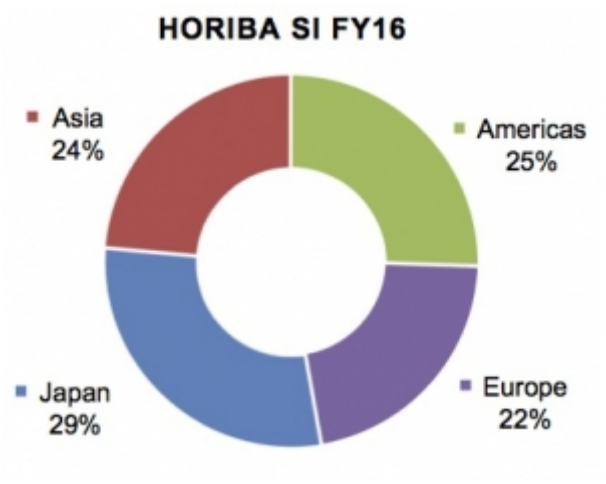
HORIBA's Scientific Instruments & Systems (SI) sales grew 1.2% to ¥7.61 billion ($69.5 million) to account for 14% of company revenues. Excluding currency, sales climbed nearly 10% driven by demand in the Americas and Europe but partially offset by weakness in Asia.

2016

Full-year 2016 P&E sales improved 0.3%, roughly 6% excluding currency, to ¥16.75 billion ($154.0 million at ¥ 108.76 = $1) to account for 10% of revenues. The company highlighted demand for process measurement equipment products in the Americas. Segment operating margin contracted 132 basis points to 9.2%. The company projected 2017 P&E sales to grow 7% to ¥18.0 billion ($164 million at ¥110.00 = $1).

SI's full-year 2016 revenue declined 3.8% to ¥25.7 billion ($236.6 million) to account for 15% of revenues. Excluding currency, sales advanced roughly 5%. Segment operating margin slipped 81 basis points to 3.7%. SI sales are estimated to grow 1% in 2017 to ¥26.0 billion ($236 million).

HORIBA Q4 FY16			
	Rev. (M)	Rev. Growth	% of Rev.
Process & Environmental Instruments & Systems	¥4,943	2.9%	9%
Scientific Instruments & Systems	¥7,609	1.2%	14%



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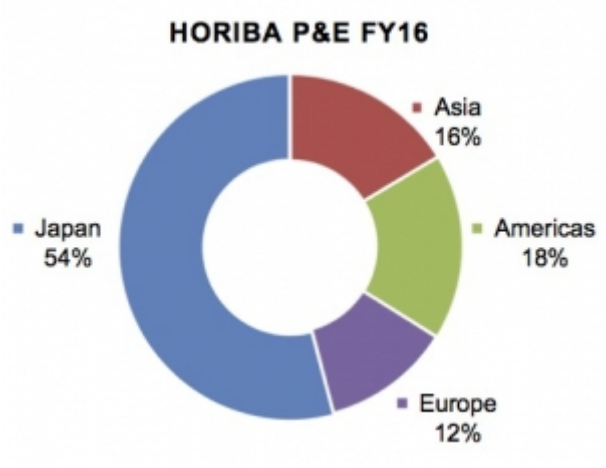

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NanoString Growth Slows

Q4 2016

Fourth quarter 2016 sales for NanoString Technologies grew 13.1% to $25.2 million. However, this growth was largely attributed to collaboration revenue, which climbed 67.7% to account for 19% of sales. Product and Service revenue, which improved 4.9% to account for 81% of revenues, was slightly below company expectations due to weaker demand for both instruments and consumables from academic customers. Instrument sales declined 5.8% due to funding delays for academic customers, as well as growing competition for genomics-related products. The company also noted that its commercial channels were inadequately supported, resulting in lower instrumentation sales productivity. Life science consumables sales advanced 10.8%, led by demand for PanCancer Immune Profiling panels. Sales of IVD kits expanded 24.8%. Operating loss widened 30.2% to $9.9 million due to increased R&D investments.

2016

Full-year sales for NanoString climbed 38.0% to $86.5 million, including collaborative revenues of $17.4 million, which nearly tripled compared to the previous year. Product and service sales jumped 22.1% to account for 80% of revenues. While the number of systems sold jumped roughly 40% to 160 units, instrument sales grew disproportionately, rising 16% due to higher placements of the lower-priced SPRINT system. The company shipped 60 SPRINT systems for the year.

Including contractual revenues, sales in the Americas, Europe/ Middle East and Asia Pacific climbed 46.2%, 24.9% and 16.2% to make up 70%, 21% and 9% of revenues, respectively. Operating loss was unchanged at $41.2 million. The company projected 2017 sales to growth 16%–21% to $100–$105 million, including collaboration sales of $19-–$20 million. Product and service revenues are expected to grow at similar rate as in 2016.

NanoString Technologies FY16				
	Q4		FY	
	Rev. ($M)	Rev. Growth	Rev. ($M)	Rev. Growth
Instruments	$7.5	-5.8%	$24.2	15.5%
Consumables	$11.0	10.8%	$37.5	22.7%
In Vitro Diagnostic Kits	$1.0	24.8%	$4.2	69.6%
Services	$0.9	18.5%	$3.2	22.3%
Collaboration	$17.4	67.7%	$17.4	187.9%

Click to enlarge

Rising Momentum for Pacific Biosciences

Q4 2016

Excluding contractual revenue, fourth quarter 2016 product and service sales for Pacific Biosciences jumped 92.2% to $24.4 million. Instrument sales soared 151% to $13.1 million, driven by increased Sequel system placements. Instrument bookings also improved on a sequential basis, as orders climbed from 20 units in the third quarter 2016 to 30. The company noted stronger interest from sequencing companies following the addition of new functions to its sample loading feature. Consequently, GrandOmics ordered 5 systems in the quarter, while Novogene place a 10-system order in January.

Consumables revenue climbed 64% to $7.5 million, as demand for Sequel consumables ramped up. Service and other revenue expanded 31% to $3.8 million.

Contractual revenue amounted to $1.3 million, representing the final amortized payment from Roche, compared to $23.6 million recorded in the previous year from both milestone and amortized payments.

Product and service gross margin jumped from 23% to 41% due to increased system placements. Operating loss was significantly higher at $17.9 million due to lower contractual revenues.

2016

Full-year 2016 product and service sales for Pacific Biosciences climbed 62.4% to $78.6 million. Instrument sales more than doubled to $41.0 million, as the company ended the year with an installed base of more than 110 Sequel systems. Consumables sales advanced 26% to $23.7 million, while service and other revenue improved 28% to $14.0 million. Contractual revenue declined 73% to $12.1 million. Overall, sales in North America, Europe and Asia accounted for 56%, 22% and 22% of revenues, respectively. Reported 2017 sales are expected to climb 21%–38%, including product and service revenue growth of 40%–60% and zero contractual revenue.

Pacific Biosciences FY16				
	Q4		FY	
	Rev. ($M)	Rev. Growth	Rev. ($M)	Rev. Growth
Product	$20.6	110.2%	$64.6	72.3%
Service and Other	$3.8	31.1%	$14.0	28.2%
Contractual	$1.3	-94.3%	$12.1	-72.7%

Click to enlarge

New Systems Elevate Tecan

H2 2016

For the second half of 2016, Tecan sales advanced 12.7%, 7.3% organically, to CHF 271.0 million ($273.7 million at CHF 0.99 = $1). Currency and acquisitions added 0.5% and 4.9% to sales growth, respectively.

Organic sales growth for the Life Sciences Business (LSB) accelerated in the second half of the year, climbing 7.5% due to continued adoption of its new Fluent liquid handling platform and Spark line of microplate readers. Increased demand for services, consumables and reagents also contributed to segment growth.

Partnering Business sales advanced 7.0% organically, driven by increased production and placements for one of its customers, Ortho Clinical Diagnostics' automated analyzer. Component sales were similarly strong, led by demand in China and from NGS customers. Segment operating margin slipped 166 basis points to 11.9% due to acquisition-related costs following the purchase of Sias (see ***IBO*** 10/31/15).

All sales figures below are expressed in local currency but include acquisitions. Sales in Asia and North America climbed 24.5% and 14.0% to account for 16% and 42% of Tecan sales, respectively. European sales slipped 0.5% to make up 38%. Sales in Other regions jumped 87.1% to represent 3%.

Tecan orders declined 2.8% organically to CHF 252.6 ($255.2 million) due to timing of a large order within the Partnering Business. Operating margin fell 243 basis points to 14.9% as a result of acquisitions and higher sales of new instrumentation, which carry lower gross margins.

2016

Tecan 2016 sales climbed 15.0%, 8.2% organically, to CHF 506.2 million ($511.3 million at CHF 0.99 = $1). The company achieved record annual sales due to strong demand for new instrumentation, higher recurring revenues and robust growth in China. Currency and acquisitions further contributed to sales growth, adding 1.5% and 5.3%, respectively.

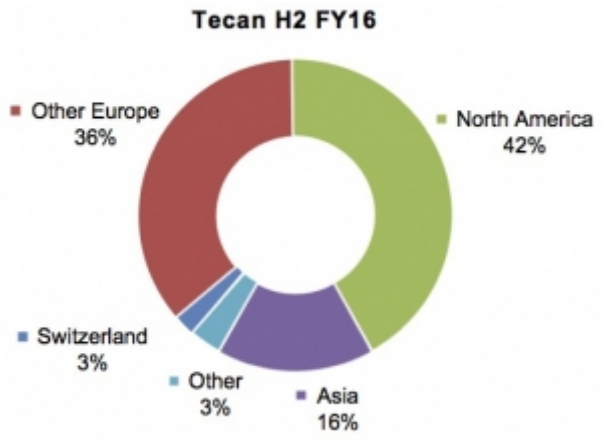
LSB sales grew 6.8% organically, driven by demand for the new Fluent and Spark systems. Sales of plastic consumables, primarily pipette tips and microplates, were also healthy. Segment growth further benefited from expanded operations in China, including strong demand from diagnostics customers in the region. LSB operating margin contracted 165 basis points to 16.3% due to product mix.

Organic sales for the Partnering Business advanced 10.1% due to higher production volume for Ortho Clinical Diagnostics' ORTHO VISION Analyzer and strong components sales. Segment operating margin declined 118 basis points to 14.9% due to the acquisition.

In local currency but including acquisitions, Tecan sales in Asia, Europe, North America and Other climbed 27.0%, 12.8%, 7.6% and 52.3% to make up 16%, 43%, 39% and 3% of revenues, respectively. The company highlighted sales growth in China, which soared roughly 50% including acquisitions to account for 10% of revenues. Orders improved 1.8% organically to CHF 503.2 ($508.3 million), as strong LSB order growth was partially offset by a

missed order within the Partnering Business. Despite higher pricing, Tecan gross margin contracted 160 basis points to 47.3% due to the acquisitions and product mix.

The company projected 2017 sales to grow at least 6% in local currency, which should equate to roughly a minimum of 3% growth organically.



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ABRF 2017

In the March 31, 2017 issue of ***IBO***, we reviewed our visit to the annual Association for Biomolecular Resource Facilities (ABRF) meeting (see ***IBO*** 3/31/17). In the article, we detailed the ABRF Genomics Research Group's study of five single-cell (sc) RNA-Seq techniques. John Ashton, PhD, a Group member; Research Assistant Professor, Department of Microbiology & Immunology; Associate Director, Genomics Research Center; and Co-Director, Pathway Discovery Resource (High-Throughput Screening Facility), at the James P. Wilmot Cancer Institute, University of Rochester, provided ***IBO*** with a statement regarding the study. "Although each of the evaluated scRNA-seq platforms is capable of accurately identifying the treatments groups (vehicle vs. TSA [two different preparations of the samples]), the extent to which the groups are delineated is variable. Importantly, we observed a low degree of correlation between the 'biomarker genes' identified across each platform, where only a handful of genes were cross-platform validated. These data suggest further efforts to understand these variable results is imperative to develop methods that can account for these differences allowing for comparison of results across platforms."

LC-TOF MS

A TOF MS is designed to separate ions that have identical kinetic energy but a different mass-to-charge ratio. In essence, it consists of a long tube, which connects the sample source to a detector, in which ions expelled from the source move toward the detector in order of increasing mass. When combined with an HPLC or other liquid separation technique, these instruments are ideal for analyzing large molecules or identifying compounds in complex matrices.

Following chromatographic separation, the LC-TOF MS instrument bombards the ions of the sample with electrons. This is often accomplished using electrospray ionization (ESI), although other techniques can be used as well. The positive ions are attracted to a negatively charged set of plates with a small gap between them. This accelerates the ions to the same kinetic energy and allows them to flow into a field-free drift region, also known as a flight tube, in which the lighter ions reach the detector first. In fact, the ions arrive at the detector in a sequential order of mass, making it theoretically possible to detect all the ions present in the source. The resulting spectra is used to perform identification and quantification of known and unknown analytes. In contrast to other MS techniques that only let through a narrow range of masses at each point in time, LC-TOF MS has very high sensitivity, speed and resolution

but does not allow for structural analyses.

Popular modifications to the basic LC-TOF MS technique include Q-TOF MS instruments, which incorporate a quadrupole mass filter before ions reach the flight tube, and MALDI as an ionization method. Excluding Q-TOF and MALDI-TOF MS instruments, the total market for LC-TOF MS was almost $100 million in 2016. Even though LC-TOF MS lacks the capabilities of other enhanced MS techniques, it fills an important price-to-performance segment of the market and can be used in a wide range of applications.

The pharmaceutical industry accounts for the bulk of demand for LC-TOF MS instruments, for which the technique is considered cost effective for routine studies. Demand from environmental labs and the food industry is also substantial, as LC-TOF MS is a common technique for identifying contaminants in complex samples.

Waters is the leader in the LC-TOF MS market, as it has been for many years. Among its systems are the Xevo G2-XS TOF MS platform. Agilent Technologies and Bruker also maintain competitive market shares. Despite its sales growth being overshadowed by new Q-TOF MS products, the market for LC-TOF MS is expected to continue increasing in the low-to-mid single digits over the next few years, driven by replacement sales and growing demand in China.

Leading Suppliers:

- *Waters*
- *Bruker*
- *Agilent Technologies*

Largest Markets:

- *Pharmaceuticals*
- *Environmental*
- *Foods*

Instrument Cost:

- *$150,000–$400,000*

Forensics

Forensics: Last week, US Attorney General Jeff Sessions stated that he does not intend to renew the National Commission on Forensic Science, which is a partnership between independent scientists and the Justice Department to raise the standards of forensic science. He has also put a halt on an expanded review of FBI testimonies to meet the needs of overwhelmed crime labs, which Mr. Sessions said will be set by an appointed senior forensic advisor and an internal crime task force. Both the Commission and efforts to improve the efficiency of crime labs were set in place by former President Barack Obama. The Commission was established after numerous reports from the National Academy of Sciences regarding the lack of standards and funding for crime labs. Last fall, the Justice Department had announced it would conduct an expanded review of expert testimonies for assessing whether FBI experts gave “scientifically misleading” testimonies regarding tracing hairs found in crime scenes based on microscopic data and examining bullets based on their chemical compositions, two FBI Laboratory techniques. Mr. Sessions stated that workloads, backlogs and equipment in crime labs need to surveyed to increase productivity and accuracy of results.
Source: *Washington Post*

Government

Government: The Trump administration has proposed a budget cut of $7 million for the NIH over the next 18 months, with most cuts coming from overhead costs such as equipment and electricity bills. The decrease in government funding is a stark contrast from last year, when academic institutions received $16.9 billion for research and $6.4 billion for operational costs. Numerous researchers and administrators in academic institutions across the US have been voicing their concerns, emphasizing that basic costs for research, such as keeping labs warm and freezers functioning, are imperative to their research. MIT, for example, receives 66% of its total research funding from the government, and if the Trump administration's proposal is implemented, the institution would not receive the vast majority of funding it needs to carry out research. There are a few Republicans in Congress that do not support the Trump administration's proposed cut, so it is currently unclear if the proposal will be implemented. Supporters of the proposed budget decrease state that universities end up making profits off of the "indirect costs," such as overhead and infrastructure costs, and that the proposed cut will force universities to rethink their regulatory processes for building and maintaining labs.
Source: *Stat News*

Genomics

Synthetic biology is rapidly growing due to its great market potential and dropping prices of DNA synthesis. The cost of synthesizing DNA is currently 100 times cheaper than it was 14 years ago. Investors in synthetic biology are looking to the field to find solutions to bridge technology and biology. DNA synthesis is appealing to investors in the technology sector due to the fact that DNA is now seen as "programmable," in that it can be broken down into data and manipulated to adhere to a specific code. The number of synthetic biology companies has increased by 50% since 2011, with 411 firms now in the field. Synthetic biology network company SynBioBeta, for example, received $1.21 billion in investments in 2016, three times more than it had got in 2011. Initially, synthetic biology was used to create biofuels from algae, but now providers have branched out into creating products for pharmaceutical, fabric, fragrance and food companies, among others. Although there are ethical concerns about the limits to synthetic biology, the "disruptive" technology is gaining traction due to its potential.

Source: *Reuters*

Canada

Over the last 15 years, Canada's total Gross Domestic Expenditures on R&D (GERD) as a share of GDP has been slowly declining. This is mainly in comparison to Canada's peer group, which consists of G7 countries (US, Canada, Australia, UK, Germany, France and Italy) and key East Asian countries (Japan, Korea and China). The GERD of Canada is lower than the rest of the countries in its peer group. In 2014–2015, the average GERD intensity was 2.38%, while Canada's was 1.61%, ranking Canada as below the average and median of the Organization for Economic Cooperation and Development. Globally, Canada has also lost its place among the top 30 nations in regards to research spending.

The GERD received from federal funding is below the average of most other countries, which is largely due to Canadian policies directed towards incentivizing business R&D through tax credits. In 2014, federal research funding in Canada plateaued, although it picked up again in 2015; however, in 2015, federal research funding was still only 23.3% of all R&D funding for academic institutions. Canada's share of the global output for scientific publications increased from 377,779 between 2003 and 2008 to 496,696 between 2009 and 2014, a 24.0% increase. The Advisory Panel on Federal Support for Fundamental Science, which provides recommendations to the Minister of Science, suggests that in order to increase Canada's standing in R&D and innovation a new National Advisory Council on Research and Innovation should be developed to improve the efficiency and productivity of the governing bodies that provide funding to more appropriately disperse expenditures.

Source: *Canada's Fundamental Science Review*

Japan

Although Japan has traditionally been a leading nation in its contributions to science, the country's overall research output has dropped in recent years, settling at fifth place in *Nature*'s 2016 Nature Index. Along with Japan's own economic difficulties, China's significant increase in scientific research and research publications have also contributed to this. Between 2005 and 2015, China's science publication output grew by 300%. By 2015, nearly 1 out of every 5 scientific research papers came from China, as opposed to 1 of 10 papers a decade earlier. Because of China's high scientific output, Japan's output has decreased in proportion, with the nation releasing 600 fewer papers in 2015 than in 2005. On a global scale, this indicates that Japan's share of research publications dropped 38.1% to 5.2% during the same 10-year period. This information also correlates with data from the Nature Index, which indicates Japan's contributions decreased 19.6% between 2012 and 2016. Since 2001, government spending on science has plateaued due to the country's economic immobility, with a large portion of the spending now also going towards raising the international ranking of Japan's top academic institutions.
Source: *Nature*

China

In February, the State Council of China released details on the 13th Five-Year Plan on Food Safety (2016–2020). The Plan indicates that by the end of 2015, 135,000 food producing companies had been established, 8.19 million circulating companies and 3.48 million catering service companies. Above-scale food companies produced CNY 11.35 trillion ($1.65 trillion) that year, with yearly growth of 12.5%, and the value of food imports and exports increased 23.9%.

Although the Plan indicates that great strides in food safety were made by the end of the 12th Five-Year Plan, there are still numerous problems plaguing the industry, such as environmental pollution, inappropriate usage of agricultural inputs, the large number of small-sized producers, a lack of food safety standards and inadequate regulation and enforcement. The 13th Five-Year Plan aims to address these issues through increasing sample testing to cover all types of food; enforcing a more regulated and efficient governance of contaminated resources; re-implementing on-site inspections through developing a professional inspection team and standardizing inspection procedures and paperwork; and aligning food safety standards in China to those of international countries. Through creating a database of food safety standards of other countries and conducting R&D, China will work to improve the system for food safety by developing and updating at least 300 standards; and developing and assessing 6,600 maximum residue limits for pesticides, and 270 for veterinary drugs.

The country aims to create standards to cover all foods, including agricultural and dietary foods for "special population groups," by 2020. To help implement this, China will establish a legislative system for food safety as well as revamp the Agricultural Product Quality and Safety Law, the Implementing Rules of the Food Safety Law and the Administrative Rules for Pesticides, among others. Foreign food safety systems will be subject to inspections, both imported and exported food will undergo more rigorous inspection, and retrospective reviews will be undertaken of food safety systems of the top 50 countries that export foods to China. Additionally, the Plan states that China will update the list of non-food-use substances and prohibited pesticides that are illegal to use as food additives.

Source: *USDA Foreign Agricultural Service*

Sequencing

Company Announcements

Sarah Cannon, the Cancer Institute of Hospital Corporation of America, merged with **Genospace** in January to become a wholly owned subsidiary. The companies will harness and use molecular profiling data to more effectively match cancer patients to cutting edge therapies in clinical trials. The genomics data technology will be integrated into Sarah Cannon's network of oncology programs across the US and UK.

GRAIL announced in March that it raised over $900 million through the first close of Series B financing (see ***IBO*** 2/28/17). Strategic investors included **Amazon**, **Bristol-Myers Squibb**, **Johnson & Johnson Innovation** and **Merck**. Proceeds were used to repurchase a portion of Illumina's stake in the company, reducing its ownership to less than 20%. GRAIL anticipates a second close.

In March, **Illumina** announced a partnership with the **Institute of Medicinal Plant Development** (**IMPLAD**) to create the first catalog of genomic references for medicinal plants used as sources in Traditional Chinese Medicine (TCM). The first phase will establish a genomic reference for approximately 500 medicinal plants used in TCM utilizing Illumina NGS platforms. After completion and review of the first phase, IMPLAD and Illumina may negotiate a renewal agreement to sequence another 500 medicinal plants to complete the genomic reference for the **One Thousand Medicinal Plant Genome** (**1KMPG**).

In April, **Illumina**, the **Human Vaccines Project** and **Vanderbilt University Medical Center** announced an effort to decipher the human immunome, the genetic underpinnings of the immune system.

Illumina announced in April the donation of more than eight thousand associations of somatic genetic alterations to the **Clinical Interpretation of Variants in Cancer** resource, an openly accessible database hosted by **Washington University in St. Louis**. Illumina is now the largest donor.

The **Munich Leukemia Laboratory** (MLL) announced in March a partnership with **IBM Watson** and **Illumina** to build a new cognitive technology prototype that aims to help researchers improve leukemia treatment. MLL will use Illumina's NovaSeq technology to sequence samples from its biobank of more than 500,000 cases. MLL researchers will use Watson to help interpret the genomic data alongside other data sources. The project intends to include innovative testing processes such as automated phenotyping and genotyping, including whole genome sequencing and RNA-Seq in 5,000 cases. MLL will utilize Illumina's BaseSpace Informatics Suite, including BaseSpace Cohort Analyzer and BaseSpace Correlation Engine.

In March, personalized medicine firm **Kailos Genetics** entered into a comarketing agreement with **Illumina** for the Kailos TargetRich line of research solutions for pharmacogenetics targets. The covered product lines are the TargetRich PGxComplete reagent and Kailos Blue data analysis solution.

Armonica Technologies has been formed to develop a DNA sequencing platform to sequence a complete human genome in minutes using optical nanopore sequencing. The technology was licensed from the **University of New Mexico**.

ZS Genetics and **Hitachi High-Technologies** announced in March a strategic collaboration to develop and commercialize ZS Genetics' DNA sequencing platform, which is based on high-resolution electron microscopy and can sequence high-quality long reads (50,000+ base pairs) in single DNA molecules.

In March, ChinaMoneyNetwork.com reported that **BGI Genomics** plans an IPO on China's Shenzhen Stock Exchange, with the aim of raising $250 million. Regulatory filings show the company generated 2016 revenues of $250 million, with "fertilization and health services" accounting for 55% of sales.

In March, **GENALICE** and **BioDiscovery** entered into a comarketing partnership, under which their respective secondary analysis and NxClinical tertiary informatics genomics interpretation system will be offered together.

Omicia announced in March its rebranding as **Fabric Genomics**.

Fabric Genomics partnered in March with algorithm developer **Sentieon** to enhance its secondary analysis capabilities within its Fabric Enterprise platform (see below). The new Fabric Standard secondary analysis solution has no down sampling of reads and is deterministic. The companies plan to codevelop variant calling capabilities for hereditary disease and oncology, including structural variant and CNV capabilities.

In March, **Fabric Genomics** entered into a technology partnership with service provider **Veritas Genetics** to accelerate Veritas' myGenome product for personal whole genome sequencing using Fabric's Fabric Annotation.

In April, **Fabric Genomics** partnered with genomic cancer diagnostics company **TOMA Biosciences** to codevelop end-to-end oncology genomic testing and clinical interpretation offerings for clinical labs.

In March, **Advanced Analytical Technologies** and **TTP Labtech** announced a comarketing agreement for their respective Fragment Analyzer and mosquito automated low-volume liquid handler.

Biomedical data analysis firm **Seven Bridges** announced in March a strategic partnership, including an investment, with **Spatial Transcriptomics**, which develops tools for visualizing gene expression within tissue samples.

Seven Bridges announced in April that the **Simons Genome Diversity Project** dataset, which it called the largest dataset of human genetic variation ever collected, is now available for researchers via the Seven Bridges Platform.

In April, **Paragon Genomics** introduced the CleanPlex target enrichment solution and CleanPlex OncoZoom Panel covering the hotspots of 65 key oncogenes, panels covering the entire coding regions of specific genes and a CleanPlex targeted library preparation kit. CleanPlex background cleaning technology removes nonspecific PCR products generated during highly multiplexed PCR reactions.

GenDx announced in April a global reseller agreement with **Thermo Fisher Scientific** for the rights to offer an end-to-end workflow to HLA typing labs that includes Thermo Fisher's Ion Torrent NGS systems and consumables with GenDx's assays and analysis software for allelic-level HLA typing analyses.

1CellBiO, which is developing the inDrop technology for high-throughput single-cell RNA sequencing, announced in April a research collaboration with pharmaceutical firm **UCB**.

Product Introductions

Lexogen introduced in March its RNA-Seq service, focused on gene expression profiling.

In March, **SYGNIS** launched the TrueAdvance DNA amplification and validation service for supporting single cell and liquid biopsy NGS applications.

Oxford Nanopore introduced in March the GridION X5, which can run up to five MinION Flow Cells and process the data on a single benchtop device. It can generate 100 GB of data over 48 hours. According to *Bio-IT World*, the system is available for $125,000 with each flow cell priced at $299. Alternatively, users can commit to 300 flow cells at $475 per cell and pay a $15,000 fee. Oxford Nanopore will offer sequencing-as-a-service certification on the system.

Agilent Technologies launched in March the Agilent SureSelect Clinical Research Exome V2, a new target enrichment solution for NGS. It features more than one thousand additional disease-relevant targets compared to the prior version.

In March, **Fabric Genomics** introduced Fabric Enterprise, an optimized genomic platform enabling secondary analysis, rapid annotation, guideline-driven variant classification and clinical reporting for both hereditary disease and oncology.

Swift Biosciences released in March the Accel-Amplicon CFTR Panel for interrogating the coding region and select introns within the Cystic Fibrosis Transmembrane Conductance Regulator (CFTR) gene for disease-relevant mutaitons and variants. It covers a genetic footprint of 10 kb and produces ready-to-sequence libraries in two hours.

In March, **SeraCare Life Sciences** introduced the SeraSeq Inherited Cancer DNA Mix reference materials for NGS. The product combines over 20 pathogenic variants of diverse types in a well-characterized genomic background that can be used for assay development and analytical validation.

Bioline released in March the JetSeq Library Quantification Kit, a qPCR-based assay for quantification of adaptor-ligated DNA fragments during preparation of **Illumina**-compatible NGS libraries.

SGI-DNA released in March NGS Library Construction Kits for the BioXp 3200 System.

Strand Life Sciences introduced in March Strand NGS 3.0, featuring a DNA-Seq workflow that is 1.5–2x faster than the BWR-GATK best practices workflow.

In April, **BioDiscovery** released Nexus Copy Number 9.0 for integrated analysis of copy number, sequence variation and loss of heterozygosity. The latest version features support for a wider range of sequencing technologies.

NuGEN Technologies introduced in April the Universal Plus mRNA-Seq and Trio RNA-Seq kits that enable RNA-Seq analyses from routine samples to those isolated from sources like cfRNA and FFPE which normally produce rare or low-quality nucleic acids. The Universal Plus mRNA-Seq kit features the option to eliminate unwanted transcripts after library construction using AnyDeplete technology. The Trio RNA-Seq kit provides a highly sensitive whole transcriptomics solution that is ideally suited for application with low-abundance transcripts.

In April, **Roche** announced the Certified Service Provider program for SeqCap EZ Target Enrichment Systems utilizing Kapa library preparation kits. **Centro Nacional de Análisis Genómico** in Spain and **Genergy Bio Technology** in China have achieved certification.

Sales/Orders of Note

In March, **PierianDx** announced six new customers for its “One Space” genomics software solution: **Cedars-Sinai Medical Center**, **Dartmouth-Hitchcock Medical Center**, **Florida Hospital**, **Georgia Esoteric & Molecular Laboratory at Augusta University**, **NorthShore University HealthSystem** and **the University of Arkansas for Medical Sciences** (**UAMS**).

Novogene, a genomics services provider, announced in April an order for 25 **Illumina** NovaSeq 6000 sequencers, consisting of 5 for the US and 20 for China, purchased by **Nanjing Yangzi State Owned Investment Group**.

Atomic Spectroscopy

Company Announcements

In January, **PANalytical** named **Aimil** as a representative for its XRF systems, Claisse fusion instruments and flux, as well as its ASD NIR products in India.

In March, **PANalytical** and **Cambridge Crystallographic Data Centre** announced that users of the Cambridge Structural Database can now utilize it with PANalytical’s HighScore software for the analysis of powder diffractograms without additional cost.

Lyncean Technologies, a manufacturer of miniature synchrotron x-ray sources, signed an exclusive distribution agreement in April with **Shanghai Physion** for China.

Product Introductions

In February, **Shimadzu** launched the PDA-MF and PDA-MF Plus, its first tabletop OES systems, designed for emerging markets. The PDA-MF is designed for the analysis of nonferrous metals. The PDA-MF Plus is for analysis of a wide range of samples. The systems emphasize ease of use and cost efficiency.

Shimadzu released in March the Small Spot Analysis Kit for its EDX-7000 and EDX-8000 ED-XRF systems. The kit allows analysis of small contaminants with a less than 0.04 in (1 mm) diameter, and analysis of plating thickness of small areas.

In March, **Thermo Fisher Scientific** introduced the Thermo Scientific ARL QUANT’X EDXRF spectrometer, which

is designed to be more than four times more sensitive than the previous version. It features a 50 W x-ray tube and latest generation SDD to enable analysis of light elements and small-spot analysis.

Spectro Scientific released in March Version 8 of its SpectrOil Series analyzers, featuring stability improvements and an enhanced user experience.

Analytik Jena introduced in March the compEAct series of combustion-based analyzers for the determination of TS and TN in organic elemental analysis. It features a small footprint and flexible degree of automation.

In April, **Rigaku** launched the Rigaku SmartLab SE system, a multipurpose XRD with built-in intelligent guidance. It features the next generation HyPix-400 2D detector and, with it, can operate in 0D, 1D and 2D modes without the need to exchange the detector.

Order/Sale of Note

The **Laboratoire Léon Brillouin** research lab at France's **CEA Saclay** installed the **Xenocs**' Xeus 2.0 HR SAXS/WAXS instrument in December 2016.

In April, **Rigaku Oxford Diffraction** announced that the **University of Manchester School of Chemistry** plans to install the Rigaku XtaLAB FR-X DW XRD system.

In March, **Bruker** announced the delivery of a D8 DISOVER HTS high-throughput XRD system to **Alcami**, supplier of pharmaceutical development and manufacturing services, as part of a collaboration agreement.

Informatics

Company Announcements

In February, **Genedata** announced **BMG LABTECH**, **Creoptix** and **TTP Labtech** as new members of its Ready-to-Run program. The program enables members' customers with an out-of-the-box, efficient connection of their respective instruments with the Genedata Screener platform.

Genedata established in February a new subsidiary in the UK, based in Duxford, Cambridgeshire.

IDBS expanded its strategic technology partnership with **ChemAxon** in May, making ChemAxon's Biomolecule Toolkit for biomolecule-structure indexing and BioEddie platform for web-based biomolecule drawing available as part of E-Workbook suite.

In March, **Sapio Sciences** opened an office in Cambridge, Massachusetts.

LIMS provider **Eusoft** announced in April a commercial and technology partnership with **Infinity Group** for Poland and the Eastern European market.

In April, **Simulations Plus** announced a distribution agreement with **Quantum Bio Solutions** (**Q-Bio**) for South Korea.

In April, **Optibrium** and **Lhasa**, providers of software for small molecule property prediction, design and optimization, announced a collaborative partnership to research next generation drug metabolism modeling.

Product Introductions

Lab-Ally released in January the private server–based CERF ELN and EDMS (Electronic Document Management System) 5.0, featuring a new CERF Exporter app.

IDBS announced in March the extension of its E-Workbook Cloud to include pre-qualified service for GxP. The company has delivered over 30 validated installations of the system.

In March, **LabKey** and collaborator **Just Biotherapeutics** announced the initial release of LabKey Biologics, featuring tools for biological entity registration, assay data integration and workflow management.

Autoscribe Informatics launched the Matrix Gemini Field Analytics System, which allows test data to be recorded offline and uploaded to the LIMS when the Internet connection is re-established.

PerkinElmer launched in March the PerkinElmer Signals Notebook, a cloud-based ELN, which can be implemented immediately. It is fully integrated with Microsoft Office and Microsoft Office Online.

In March, **Sapio Sciences** released its Exemplas LIMS/ELN 9.0. It features the ability to support huge amounts of data without impacting general system performance, and new template-creation features.

Sales/Orders of Note

In February, **IDBS** announced that **Achillion Pharmaceuticals** adopted its E-WorkBook for electronic lab data capture.

In February, **Autoscribe Informatics** announced the purchase of its Matrix Gemini LIMS by a veterinary lab of **Agrihealth Group**, a provider of services supporting the agricultural and food production industries.

Molecular Spectroscopy

Company Announcements

In March, **ACD/Labs** announced a collaboration with Dr. Jacob Fisher of the **University of Waterloo**. He implemented ACD/NMR Predictors software as a student learning tool in his introductory computational chemistry course.

B&W Tek announced in March that its TacticID handheld Raman spectrometer is now available as part of the **US Communities National Cooperative Purchasing Program** through the distributor **Safeware**.

Applied Photophysics named Paul Walker, managing director of **Malvern Instruments**, to its Board in March.

In April, **Nanophoton** named **Analytik** as its exclusive distributor for the UK and Ireland.

Product Introductions

In March, **Daylight Solutions** launched the Spero-QT, its second generation high-performance IR chemical imaging microscope. The new system can produce twice the level of data in one-tenth of the time as the previous model. The instrument footprint is smaller and the stage travel has been increased to accommodate up to three slides.

Jenway, a **Cole-Parmer** company, introduced the 7205 UV/Visible spectrophotometer, with a wavelength range from a minimum of 335–198 nm to include the UV area. It is designed for fast and easy use in analytical chemistry, routine analysis and education laboratories.

In March, **Uniqsis** released the Flow-UV, an affordable in-line UV/Visible spectrophotometric detector for flow chemistry applications. It can be used with almost any commercial flow chemistry system. The detector can be positioned nearly anywhere in the flow path, and the reaction can be monitored over up to five wavelengths.

Bruker announced in March the PotencyMR solution, a cost effective “one-stop” NMR approach for determining the

potency of drugs.

Bruker announced in March the VERTEX 80v, the verTera THz extension to its VERTEX FTIR spectrometer, which combines FTIR and continuous wave THz spectroscopy. It can be configured for spectral range from <3cm^{-1} up to 50,000cm^{-1} without cryogenically cooled components.

In March, **Bruker** announced the minspec G-Var benchtop TD-NMR solution for the fast determination of droplet-size distribution in food emulsions. It is based on a collaboration with **Unilever**.

Bruker launched in March the AVANCE NEO platform, its next generation NMR electronic console, offering faster control, improved dynamic range, and enhanced flexibility and scalability compared to the previous generation. The range is now extended to 1.2 GHz and beyond, and each console offers multiple receivers as a standard feature.

In March, **Bruker** introduced the TopSpin 4 software for its AVANCE NEO platform, featuring a new user interface and capabilities to support multiple receivers. The bioTop module performs most biomolecular tasks in full automation. The TopSolids module for solid state NRM is designed to give easy access to the delicate setup of probe hardware and complex solid state NMR experiments. Bruker also released the iProbe platform, a novel NMR probe architecture for increased signal to noise, and faster and more accurate RF tuning. Two new InsightMR applications were released: InsightXpress for NMR monitoring of reaction conditions, and InsightCell for monitoring live cells.

Paraytec released in March a new Large Area Detector system based on its ActiPix D200 UV/Visible Imaging Platform.

In March, **Magritek** introduced the Spinsolve ULTRA Benchtop NMR system, featuring the field homogeneity of a superconducting NMR magnet, for measuring sub-milli-molar components of mixtures in under 10 minutes. No sample preparation is required. It is available with multiple different nuclei, and with an operating frequency of 43 MHz or 60 MHz (for ^{1}H).

In April, **Edinburgh Instruments** launched the FLS1000 Photoluminescence Spectrometer, calling it “a complete luminescence lab in one instrument.” It can be configured for spectral measurements from the UV to the mid-IR spectral range, and for lifetime measurements spanning time resolutions across 12 orders of magnitude from picoseconds to seconds. It features new electronics modules and the new Fluoracle software suite.

Sales/Orders of Note

In February, **Edinburgh Instruments** announced the installation of the FIRL 100 CO_2/FIR (THz) laser system at Dresden High Magnetic Field Laboratory at the **Helmholtz-Zentrum Dresden-Rossendorf**. The system will be used for multifrequency pulsed-field (up to 70 T) ESR spectroscopy of strongly correlated magnets.

Reported Financial Results

$US	Period	Ended	Sales	Chg.	Op. Prof.	Chg.	Net Prof.	Chg.
Bioanalytical Systems (Products)	Q1	31-Dec	$0.9	8.3%	($0.2)	13.5%	NA	NA
IDEX (Health & Science Technologies)	Q4	31-Dec	$188.3	0.9%	$36.7	-8.4%	NA	NA
IDEX (Health & Science Technologies)	FYE	31-Dec	$744.4	1.0%	$121.9	5.3%	NA	NA
MTS Systems	FYE	1-Oct	$650.1	15.3%	$41.8	-32.1%	$27.5	-39.5%
MTS Systems (Test)	FYE	1-Oct	$512.3	10.7%	$40.7	-3.8%	NA	NA
MTS Systems	Q1	31-Dec	$199.3	41.8%	$10.3	-24.3%	$1.7	-85.5%
MTS Systems (Test)	Q1	31-Dec	$131.1	10.4%	$11.7	12.8%	NA	NA
Pressure BioSciences	Q4	31-Dec	$0.4	15.3%	($1.2)	-25.8%	$3.2	NM
Pressure BioSciences	FYE	31-Dec	$2.0	9.9%	($3.7)	-4.8%	($2.7)	63.6%
Simulations Plus	Q2	28-Feb	$5.7	10.5%	$1.8	4.6%	$1.2	4.4%
Other Currencies								
Eurocontrol Technics	Q3	30-Sep	CAD 0.3	-9.0%	(CAD 1.5)	-65.0%	(CAD 1.2)	-451.4%

NA = not available, NM = not meaningful