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Unlocking the Potential: Reconsidering Lab Data

Informatics has changed the way lab data is collected, stored, shared and analyzed. However, it is widely agreed that the full potential of laboratory data, for example, metadata, aggregated data and even the experimental results themselves, has yet to be realized; in particular, the application of these types of data to solve scientific challenges,

such as productivity, reproducibility and large-scale integration. By re-imagining the traditional paradigms for lab data, companies are utilizing novel approaches to increase the value of laboratory data, the experimental process as a whole and scientific discovery in general,

BioBright

BioBright utilizes hardware and software to easily record lab data and integrate it for analyses. The company's focus is biological applications, especially the pharmaceutical industry's needs from discovery, through clinical testing and manufacturing. Partners include the Sanger Institute, US Department of Defense's DARPA (Defense Advanced Research Projects Agency) and major pharmaceutical companies.

Tools for Insight

Darwin consists of three main tools. "One is a Dropbox-like tool that automatically collects data from equipment, computers and other infrastructure that is deployed in typical pharmaceutical and research workflows," explained Charles Fracchia, founder and CEO of BioBright. "The second is a voice assistant, very similar to Siri or Alexa but the difference is we have the knowledge of all the custom vocabulary that goes on in the laboratory." The third, Darwin Terminal, is a touchscreen dashboard for data visualization and analysis.

As Mr. Fracchia told *IBO*, "One of the big tensions is that the current paradigm for doing work in laboratory science requires a lot of manual labor and a lot of physical dexterity. The issue is doing the experiment and documenting the experiment are diametrically opposed in terms of activities." The result is lost insight and experimental knowledge. "What happens today is that scientists are doing an experiment and they try to remember all the minutiae and variation that may have happened, and only write them down in their lab notebook later on," he said.

But Darwin Speech, the voice assistant, enables the data to be collected in real time with context. "For example, one can make a note by just saying, 'Darwin, sample 3 looks cloudy,' or 'Darwin, I think the yield on this step is going to be low,'" explained Mr. Fracchia. "We know who said it, we know at what time, in what context, which instruments were used, which samples were being used, and all that information is basically available to the user after the fact."

Maximizing Available Information

Previously, much of this contextual data may have been systematically collected rarely, if at all. "There's a lot of unrecorded information. There's a lot of institutional information. There's a lot of interaction information that is really crucial to how a company operates," noted Mr. Fracchia. Such information comes from both inside and outside a particular lab, such as from scientific presentations or even another lab in the same company that has completed the same experiment. "Our system, because it collects all the context from the data, from the presentation, from the equipment information, from the voice notes that people give, and also integrates with electronic lab notebooks, can get all the historical information." But, as he emphasized, this solution does require a change in workflow. "Our tools are designed to be completely transparent to the workflow, the way it is done today. We not asking anybody to really change their workflow."

The collection, aggregation and integration of such data can provide new insights, such as the source of experimental error or discovery of best practices. "That's the reason we collect information that may look seemingly tangentially related, but [in one example] we were able to find distributions of dispensing operations, and find in this case that there was an unusual distribution due to a human factor," noted Mr. Fracchia. "What we've found is most useful are metrics that help scientists create a baseline of parameters that they know or that they suspect are playing an important role. Our system helps them hone their skills, their intuition and their knowledge about a particular workflow—something that today a machine cannot do," he noted. He emphasized that Darwin augments what scientists do, rather than replacing scientists with automation.

The range of data available provides for key analyses and discoveries to me be made. "So everywhere from log files of dispensers, to calibration information of a plate reader, to historical data for the same compounds, we bring in, so you can ask those questions and then display it on a 'mission control' view." As he put it, "You cannot improve what you cannot measure."

Adding Instrument Data

As a data integrator, the company is very different from an ELN provider, emphasized Mr. Fracchia. "We are the glue that collects all of the information and then makes it available through APIs to any other vendor that wants to integrate with it." This includes instrument data. "In fact, we see our role as being really key in interacting with those existing established players to really augment everybody's capabilities... We are there to provide this interoperability layer for everybody who wants it."

Further Insights

Mr. Fracchia also spoke to the future potential of BioBright's technology. "[O]ur goal is squarely aimed at providing information and insights that will augment the human scientist in that workflow. You design things very differently when you can do that," he explained. "Now, all of a sudden, you can start asking questions like, 'Darwin, show me all images with a particular cell line in them,' or 'Darwin, show me the distribution of the drugs to the organisms that we've tried, and put that together with the results.'" This influences how a scientist works. "Our goal if we are successful is that scientists, when they are doing their work, never leave the scientific plane of thinking."

Riffyn

As with BioBright, Riffyn seeks to address lab data in new ways. The company is targeting a range of industries, including pharmaceutical, chemical and agricultural companies. Partners include Novozymes. Siemens Venture Capital is among its investors, with the company having raised $4.6 million in funding as of July 2016.

Building a Process

Riffyn's cloud-based Scientific Design Environment (SDE) consists of several components: Riffyn Map, which enables a scientist to record experimental procedures into process flow diagrams; Riffyn Track, whose Measure mode joins procedural data with results data as well as joins related data across steps in the process; Riffyn Discover automates the joining of data, resulting in a comprehensive data table that can be downloaded; Riffyn Share; and Riffyn Bridge. Features include visual process design, retention of past versions, standard and customizable ontologies.

As Timothy Gardner, founder and CEO of Riffyn, told **IBO**, the solution addresses the needs of organization as a whole by transforming the data to enable new analyses and discoveries. "What is really happening is the expansion of science beyond the boundaries of a single person, or a couple of people. Answering questions is no longer about getting your own personal data set," he explained. "Scientific questions are no longer answered by one person's experiment. To do science today, you need to connect with data beyond your own personal boundaries."

Mr. Gardner breaks the scientific workflow into three parts—the human workflow, the data workflow and the process workflow. The process workflow which he described as "the architecture of your experiments in the lab, the parametrization of those experiments, and the flow of material from step to step and how it gets transformed." He calls this process workflow "the core of Riffyn."

Transforming Data

The problem now, as Mr. Gardner stated, is '[y]ou have a lot of data in a database and nobody can make any sense of it because you didn't actually articulate what was the experiment and the process by which you generated all that data." Riffyn takes a different approach. "We started with that process as the primary workflow object and all the data is wrapped around that process, so as soon as it goes into Riffyn it is already annotated with all of its metadata and all of the relationships between experimental steps and processing," said Mr. Gardner. "So that you can take that information, and you can automatically reshape the data into an analytical form. With a click of a button, everything you did across multiple processing steps, even multiple procedures and groups, can be transformed into a statistical data form that's ready for machine learning, ready for computation, ready for visualization, ready for analysis."

Such data analyses can ultimately make new discoveries. "[There is] discovery when you can pull relationships from data for which no specific experiment was conducted. That happens when you can aggregate dozens of high-quality data sets—the relationships are emergent— not detectable in the one data set, but clearly there in the many," stated

Mr. Gardner. However, current data practices do not meet these needs. "But you can't see that normally do that kind of aggregation today because data is typically siloed, inadequately annotated, and unknown or low quality."

Data for the Whole Organization

As an example, Mr. Gardner described how the SDE integrated with an organization's use of Sharepoint and how it changed the work process. "But Riffyn takes the Sharepoint request to a new level of usefulness. Their requests flow into Riffyn and it automatically sets up an experiment. They can then execute the experiment in Riffyn. This analysis can be done by a company's existing platforms," explained Mr. Gardner. "Then the data is reshaped and transported downstream to another group where it gets analyzed with another third-party tool. Riffyn becomes this glue for defining your experimental workflows and processes, annotating your data and structuring it for analysis," he added. Data analyses that can be performed include visual/interactive plotting, variance analysis and multivariant regression.

Among the tools that build on Riffyn's output is SAS' JMP platform for statistical and qualitative data analysis and visualization. "Our recommendation and favorite is JMP from SAS, which a lot of people already have and are not making as good use of as they could because they're not shaping the data into a form that's ready for JMP," said Mr. Gardner. "Riffyn does that shaping for them, and then it drops it right into JMP. Riffyn is also compatible with other analytical tools besides JMP, including Tableau, Spotfire, R and Python. We also have an SDK [Software Development Kit] supporting more than a dozen programming languages."

Integrating Data

Riffyn's solutions do not integrate directly with analytical instrument data, said Mr. Gardner, due to the infinite number of drivers that would have to be created. However, the company provides an API for those that want to write their own drivers. In addition, integration from other lab systems is possible. "In most cases, we can make the link. For example, we have a component—called a data agent—which can connect to relational databases and pull data out," he noted. "If your data is being collected by a robot which stores the data into an onboard MySQL database, we can pull the data out of there."

Synthace

Founded in 2016, Synthace has created the Antha open-source operating system for biology labs. Antha is designed to address experimental protocols and methods, rethinking experimental processes, and planning for scalability and traceability. Current customers include Merck & Co. and Dow AgroSciences. The company recently raised $9.6 million in Series A funding (see ***IBO* 10/15/17**).

Automating the Lab

As Syntace CEO Tim Fell told **IBO**, most lab work is currently executed manually, including planning. "As a result, the scale of experiment which can be easily planned and executed is limited to the capacity, skill and diligence of the investigator, rather than the true complexity of the systems being investigated." This has other limitations as well. "It also means that work is conducted, and data is recorded after the fact, often in either a paper or electronic lab notebook, where again every piece of information collected has a cost in time to enter, and introduces errors from mistakes in entry."

In addition, metadata to provide context, such as environmental data or consumables usage, is not collected, decreasing traceability. "And that lack of traceability makes it even harder to find the sources of error and noise in experimental methods, distinct from the noise in the underlying complex organisms and systems being investigated," added Mr. Fell.

Antha flips this way of working "on its head," according to Mr. Fell. "Instead of executing a process, and then recording that into some medium, such as paper or an electronic lab notebook, you define what will be done up front, augmented by a suite of design and simulation tools to help with that design process." This enables scalability. As he explained, "Because all the tacit knowledge required to perform a working practice is captured in the Antha language, and can be translated into execution using hardware from multiple manufacturers, it becomes possible to easily scale the scope of an experiment to properly address the underlying complex system, rather than being

limited to the experiment that you can personally execute."

Likewise, Antha can enhance reproducibility, "It also enables people to shift the defaults in how wet lab operations work: all work is repeatable, and working practices can be composed with [ease], enabling higher levels of abstraction and productivity to be achieved as a result," stated Mr. Fell. "It also sets out the necessary preconditions for reproducibility, as removing experimenter error from the pipeline, and providing better visibility into the sources of noise helps improve the background quality of lab work."

Experimental Workflow

Mr. Fell describes Antha as consisting of three pieces. "The first is the underlying Elements which describe the reusable working practices, such as construct assembly, or transformation, or assays, which make up the workflow for the experiment." A visual web-based experimental workflow is created. "Generally, these workflows describe the flow of actions (both purely computational and physical) which make up the experiment for a single sample or observation," he explained.

Describing the second and third pieces, Mr. Fell said, "In turn, a set of parameters, either physical inputs or data values, is passed into the workflow, enabling the systematic investigation of dozens of experiments at once easy by varying the input parameters for each run of the experiment," he explained. "Finally, this combination of parameters and workflow is scheduled against a concrete collection of connected hardware, enabling the system to produce all the low-level details needed to conduct the experiment, from what consumables will be needed, to the optimal layouts of plates and liquid handler decks to enable taking advantage of all the various capabilities of different platforms, such as multi-channel liquid transfers."

Built using the Go programming language, Antha extends the language to address biological testing. "Antha also simplifies many portions of the syntax and grammar, introduces a more powerful type system which understands scientific units and common lab objects, as well as providing types for physical objects used today," noted Mr. Fell. "[It also] introduces a process description model that guarantees all the tacit knowledge of a working practice is properly captured within Antha elements."

Lab Equipment Integration

Antha can directly interact with lab equipment and instruments. "[T]he Antha representation of the process is in turn the executable representation of the experiment, with drivers directly talking to the various pieces of lab equipment, including generating methods for a variety of pieces of lab hardware. That in turn means that data flows automatically from the devices in a structured context, with no cost in time to the investigator for that provenance." He added, "Sensors such as environmental monitors can also be easily overlaid on these experimental execution logs, enabling a full picture of the context of experimental results to be presented."

Specifically, Antha can record output files from analytical instruments, interface with vendor control software of other instruments such as liquid handlers (for example, Gilson and CyBio systems), and provide direct instrument control of basic lab equipment (currently, incubators and shakers). This also makes automation more accessible. "Lastly, because Antha workflows can be easily automated on liquid handling platforms, they make it easy to engage with automation in a flexible way, rather than the current situation where automation programming is normally restricted to a specialist automation engineer rather than being accessible to every bench scientist," said Mr. Fell.

Federal Funding for University R&D on Upswing After Four-Year Downward Trend

After a four-year decline (see *IBO* 12/15/16), US federal funding for higher education R&D increased in both current and constant dollars, according to data from Higher Education Research and Development (HERD) Survey by the National Science Foundation's (NSF) National Center for Science and Engineering Statistics. The report surveyed 902 universities and colleges that grant at least a bachelor's degree and spent a minimum of $150,000 in 2016 on R&D. Adjusted for inflation, federal HERD funding increased 1.4% between FY15 and FY16, with universities reporting current dollar R&D expenditures of $71.8 billion in FY16, a 4.8% jump.

## HERD Expenditures at US Universities by Source, FY16
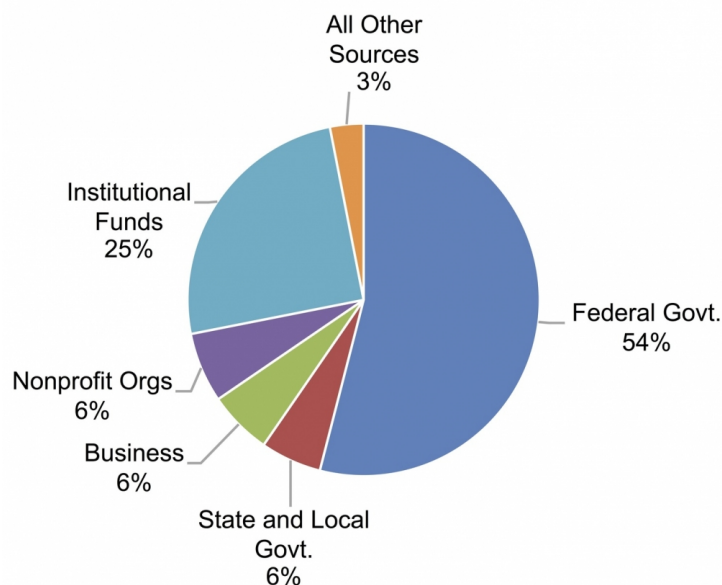
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For many years, HERD has been heavily focused on health sciences, biological and biomedical sciences, and engineering, which in FY16 represented 65% of total expenditures at $22.4 billion, $13.0 billion and $11.4 billion, respectively. Although government-funded R&D at higher education institutes grew 2.5% to $38.8 billion in FY16, the share of federal funding remained on its steady six-year decline, dropping 13.6% to represent 54% of total HERD funding in FY16. All federal funding agencies increased R&D expenditures in FY16, except the NSF, for which it nominally dropped 0.1% to $5.1 billion. The greatest increases in funding came from the Department of Defense, the National Aeronautics and Space Administration, and the USDA, for which it rose 4.4%, 5.2% and 8.0% to total $5.3 billion, $1.5 billion and $1.2 billion, respectively, of total federal HERD. The Department of Health and Human Services continues to have the greatest amount of HERD with an increase of 3.3% in FY16 to $20.7 billion. The Department of Energy HERD expenditures grew 3.6% to $1.8 billion.

Similar to last year, all nonfederal funding sources increased in FY16, growing 7.6% to $33.0 billion. The largest increase in HERD funding from nonfederal sources was from nonprofit organizations, for which it jumped 9.4% to $4.6 billion. Business funding grew 5.2% to $4.2 billion, while state and local government HERD funding was $4.0 billion, a 4.4% increase.

Business HERD Expenditures at US Universities by Field, FY15–FY16
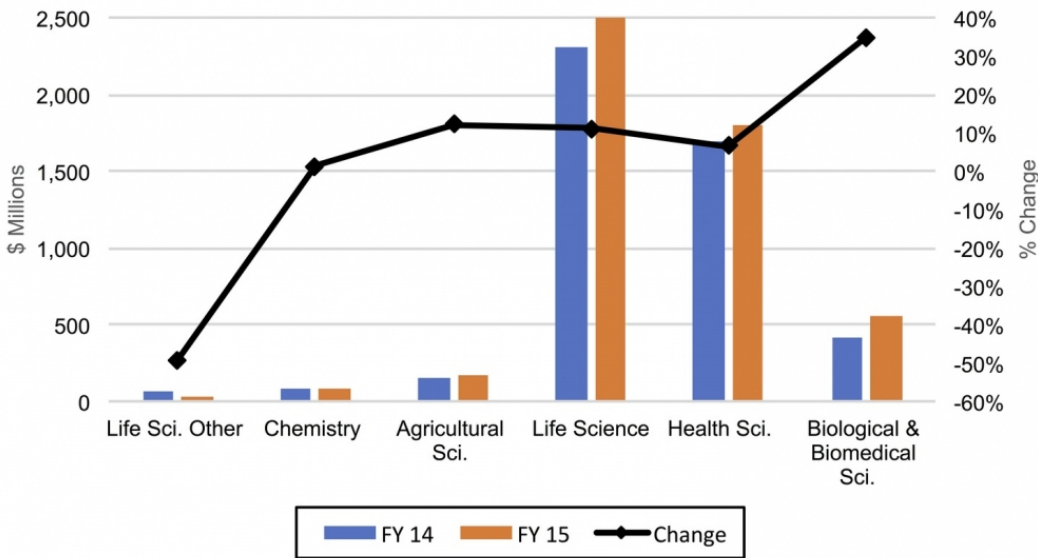
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Institution funds, defined as including "institutionally financed research (all R&D funded by the institution from accounts that are only used for research), cost sharing and unrecovered indirect costs (the portion of indirect costs associated with a sponsored project that was not reimbursed by the sponsor in accordance with the institution's negotiated indirect cost rate)," increased 8.2% to $18.0 billion. In FY16, $11.5 billion of institution funds went towards direct funding of R&D and $5.1 billion was for unrecovered indirect costs, defined as "the amount of indirect costs that are not reimbursed to the institution for externally funded R&D" in the Survey. The remaining $1.4 billion was for cost sharing on sponsored projects, a figure that has remained stable since FY13. All other nonfederal funding sources rose 8.9% to $2.2 billion in FY16.

Continuing its growth trend from recent years, university R&D expenditures in FY16 for the life sciences field, which includes agricultural, biological and biomedical, and health sciences, increased 8.2% to $40.9 billion. Over 93% of university life sciences HERD, or $35.4 billion, went towards health sciences, with biological and biomedical sciences receiving $22.4 billion and $13.1 billion, respectively, in FY16.

Federal Life Sciences HERD Expenditures at US Universities by Field, FY16
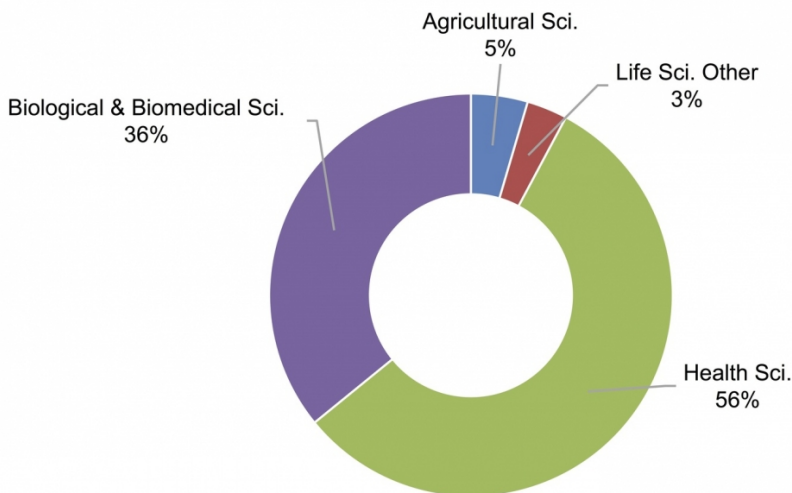
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Agricultural sciences university R&D expenditures declined 5.0% to $3.3 billion and other life sciences R&D expenditures plunged 36% to $1.5 billion. The reason for the sharp decline in the other life sciences group is due to changes in the categorization of unclassified life sciences fields, many of which were moved to the health sciences group for the FY16 HERD Survey. Within the physical sciences, university R&D expenditures increased 1.0% to $1.8 billion.

The HERD Survey also examined university R&D expenditures for equipment. The Survey defines capitalized equipment as "movable equipment exceeding the institution's capitalization threshold, including ancillary costs such as delivery and setup." Total HERD expenditures for equipment grew nominally in FY16 to $2.2 billion. This included $1.6 billion from public sources, a 1.5% increase, and $592.7 million from private sources, a decrease of 3.0%. HERD from private sources for equipment in the life sciences field also slightly decreased in FY16, dropping 0.5% to $255.6 million. Public HERD expenditures for life science equipment, however, increased 5.0% in FY16 to $588.9 million. The vast majority, or 83%, of total HERD expenditures for life science equipment was for the biological and biomedical science, and health science fields.

US University HERD Expenditures for R&D Equipment by Field & Source, FY16

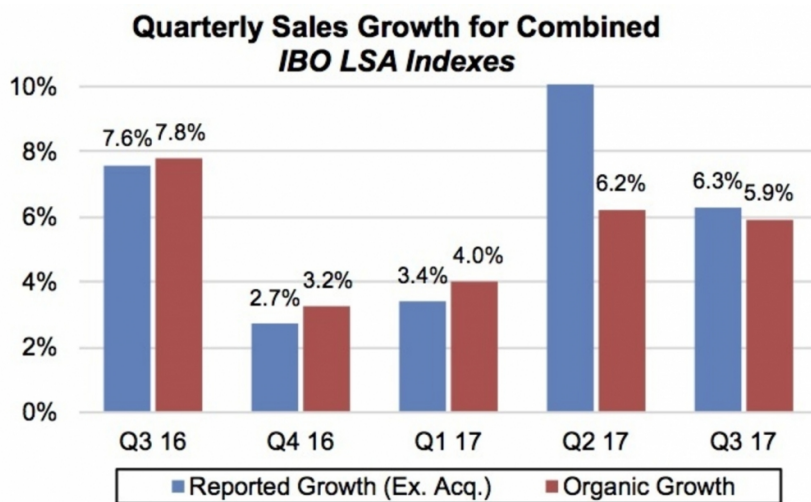| Field	Total ($M)	Federal ($M)	Nonfederal ($M)
Life Sci. Total	844.5	305.5	539.0
Biological & Biomedical Sci.	365.3	150.3	215.0
Health Sci.	337.6	120.1	217.5
Agricultural Sci.	89.0	20.7	68.3
Life Sci. Other	41.9	10.6	31.3

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Institutional rankings for the top 30 universities for R&D expenditures remained largely the same in FY16 as the previous year, with John Hopkins again at the top of the list, spending $2.3 billion on R&D expenditures, a 3.4% increase. New York University jumped 12 spots from its FY15 ranking of number 35 to number 23 in FY16, bumping the University of Texas out of the top 30. New York University increased R&D expenditures 34.6% to $810 million, which was partially driven by a rise in expenditures at its Abu Dhabi campus in Dubai. Combined, the top 30 US institutions for R&D expenditures reported $30.2 billion spent for HERD in FY16, a 6.4% increase.

Third Quarter Sales Show Mixed Pharma Results

Combined Indexes

Calendar year third quarter sales growth for publicly held instrument and lab products businesses maintained healthy, mid-single digit growth as a result of improved academic and government, and industrial end-market sales. Overall, sales to all end-markets increased, with particular strength in the applied market. Geographically, all major regions performed to company expectations, with Asia Pacific sales showing continued growth. Sales growth in Europe and the Americas also was healthy, driven by increased demand across most end-markets.

Combined calendar year third quarter sales for 14 of the 22 **IBO** *Life Science and Analytical Instrument Indexes* (*LSA Indexes*) companies and business units that have reported at publication time rose 6.3% on a reported basis. Sequentially, sales growth increased 40 basis points from 5.9%, but year-over-year growth decreased, down 1.3 percentage points. Organic growth for the **IBO** *LSA Indexes*, which excludes acquisitions and currency effects, fell 30 basis points sequentially, 1.9 percentage points year-over-year, to 5.9%.

Quarterly Sales Growth for Combined IBO LSA Indexes

Quarter	Reported Growth (Ex. Acq.)	Organic Growth
Q3 16	7.6%	7.8%
Q4 16	2.7%	3.2%
Q1 17	3.4%	4.0%
Q2 17	10.1%	6.2%
Q3 17	6.3%	5.9%

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Biopharmaceutical Markets

Third quarter biopharmaceutical sales for companies in the *LSA Indexes* that reported such results grew modestly. Sales growth remained mostly in the mid-single digits, with Shimadzu experiencing sales growth in the high-single digits. Waters' revenue growth for this market also grew solidly, driven by strong instrument system and chemistry-related sales. Bio-Techne and PerkinElmer both experienced mid-single digit biopharma sales growth, driven by continued demand in Europe. Agilent Technologies' biopharmaceutical sales declined mid-single digit, primarily due to weakened sales for nucleic acid solution products.

Academic & Government Markets

Academic and government sales for companies in the *LSA Indexes* reporting results for this market are estimated to have risen substantially, driven by Agilent and Waters. The majority of the companies in the *Index* experienced sales growth in the low-single digits for this market, with Bio-Techne and Thermo Fisher Scientific reporting mid- to high-single digit growth. Solid sales for the two companies resulted from increased regional sales, particularly in Europe and China. Similarly, Agilent and Waters both delivered double-digit growth for the market due to strong sales in Asia and Europe, as well as increased demand across most of their product lines.

Industrial Markets

LSA Index companies' sales for the industrial end-markets of those companies that specified such demand remained robust, growing in the mid-single digits. Both Waters and Thermo Fisher Scientific delivered mid- to high-single digit growth to lift *Index* industrial sales. Both companies experienced increased demand in the European region, along with strengthened demand in the Asia Pacific. Sequentially, industrial sales for Waters and Thermo Fisher each grew around 4% due to higher aftermarket and service revenues. Bruker Scientific Instrument also experienced significant sequential gains, with low-single digit growth.

Applied Markets

Applied sales for the companies in the *LSA Indexes* that reported such sales grew strongly this quarter, propelled by solid QIAGEN sales. QIAGEN delivered mid-double digit sales growth in this market, driven by forensic sales. Overall, applied sales growth increased in the mid-single digits. Food revenue for the quarter advanced substantially, largely driven by double-digit sales growth from PerkinElmer and Agilent. Environmental sales growth

was mostly positive, with Thermo Fisher revenues in this market advancing in mid-single digits.

Geographic Markets

Geographically, the Asia Pacific region delivered the fastest growth this quarter for companies in the *LSA Indexes*, with sales generally increasing nearly double digits. The strength in the APAC region was largely driven by China. Sales in China rose significantly, up double-digits in general, whereas sales in Japan grew mid-single digits in general. Asia Pacific sales among grew double digits for Bio-Techne, Fluidigm, HORIBA, Illumina, Shimadzu and Thermo Fisher. In particular, APAC sales for Bio-Techne and HORIBA grew in the mid- to high-double digits, while sales for Shimadzu and Thermo Fisher rose low double digits. However, Fluidigm experienced the fastest growth in the APAC region, as sales increased over 30%. Conversely, Nanostring Technologies' sales in the region declined mid-single digits due to weakened demand for instruments and consumables.

European sales for *LSA Index* companies are estimated to have grown in the mid-single digits in total, driven by robust academic, biopharmaceutical and industrial sales. European sales remained mostly positive, with Fluidigm and Waters delivering significant double-digit growth, and Fluidigm's sales grew nearly 50%, largely driven by a recovery in demand. Waters experienced nearly 20% growth in European sales, propelled by overall product and service revenue increases. Companies that also experienced in double-digit sales increases were Bio-Techne, Bruker, Illumina, QIAGEN and Shimadzu.
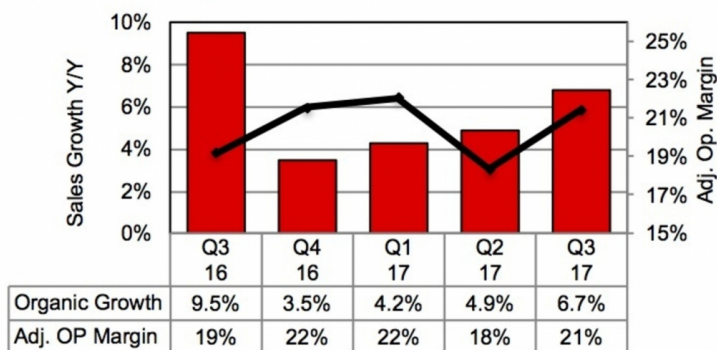
Sales in the Americas remained healthy for companies in the *LSA Index*, climbing in the mid-single digits. Most companies experienced mid-single digit sales growth, but Illumina, Nanostring and Shimadzu sales grew double-digits. Sales in the Americas for Shimadzu advanced nearly 16%, boosted by steady sales in the US. In fact, Shimadzu experienced double-digit growth across all three major regions, Americas, Europe and Asia Pacific. Illumina, which experienced around a 20% increase in American sales, similarly experienced double-digit sales growth across the three regions. Fluidigm, however, recorded a double-digit sales decline in the Americas.

Life Science Index Sales

Third quarter revenue for the **IBO** *Life Science Sales Index* for the companies that have reported increased 5.7%, on a reported basis to $4,229.1 million. Organically, sales rose 6.7%, primarily driven by strong industrial and applied end-market revenues. Sequentially, *Index* sales rose 1.1 percentage points on a reported basis. Organically, sales growth increased 1.8 percentage points from the second quarter.

However, year-over-year growth fell for both reported and organic sales. Reported sales growth decreased 3.7 percentage points, while organic sales growth fell 2.8 percentage points. Adjusted operating profit for the *Index* rose 3.0% to $933.2 million, while adjusted operating margin rose 2.2 percentage points to 21.4%.


Quarterly **IBO** Life Science Sales Index

	Q3 16	Q4 16	Q1 17	Q2 17	Q3 17
Organic Growth	9.5%	3.5%	4.2%	4.9%	6.7%
Adj. OP Margin	19%	22%	22%	18%	21%

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Analytical Instrument Index Sales

Third quarter sales for the **IBO** *Analytical Instrument Sales Index* for the companies that have announced results rose 6.9% to $4,050.0 million on a reported basis. Organically, sales rose 5.1%, driven by European sales and strong overall end-market growth. Biopharmaceutical sales, as well as industrial sales, further added to growth. Sequentially, reported sales growth decreased 60 basis points, while organic sales growth fell 2.8 percentage points. Year over year, organic sales growth fell 90 basis points, while reported sales growth advanced 1.2 percentage points. Adjusted operating profit rose 14.5% to $868.3 million, while adjusted operating margin increased by 1.2 percentage points to 20.7%.

Quarterly IBO Analytical Instrument Sales Index

	Q3 16	Q4 16	Q1 17	Q2 17	Q3 17
Organic Growth	6.0%	3.0%	3.8%	7.9%	5.1%
Adj. OP Margins	20%	23%	23%	18%	21%
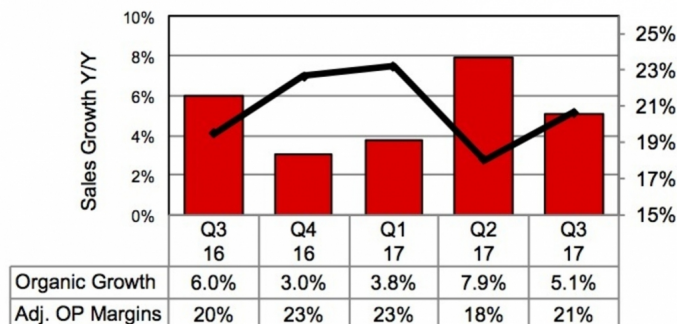
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Society for Neuroscience Conference Showcases Diverse Range of Technologies

The 47th annual meeting for the Society for Neuroscience (SfN), held November 11–15, 2017, in Washington, D.C., hosted 30,021 attendees, on par with last year's number (see ***IBO 11/30/17***). The event also welcomed 534 exhibitors, down 4.5% from the 2016 figure, that were eager to introduce their products to the attendees from 80 countries across the globe. The conference covers a wide range of areas within the field of neuroscience, with an emphasis on hot topic areas such as addiction, sleep science, PTSD, sports-related injuries and the continual battle to understand Alzheimer's.

As the premiere conference for neuroscience, SfN is a platform for companies to highlight new instruments to help study the brain. This year was no different with exciting new product announcements.

At the show, Quanterix created quite a buzz with a new product announcement for the Quanterix SR-X Ultra-Sensitive Biomarker Detection System, which employs Simoa (SIngle MOlecule Array) technology to provide ultra-sensitive biomarker detection of proteins and nucleic acid biomarkers directly from blood without PCR. The Simoa technology spans several different research areas (oncology, neurology, cardiology, inflammation and infectious diseases) and is particularly useful in detecting biomarkers for neurodegenerative diseases, such as Alzheimer's, multiple sclerosis and sports-related injuries such as CTE. Additionally, the company has already raised $80 million in financing ($55 million dilutive and $25 million non-dilutive). During a sit-down interview at the conference with the CEO of Quanterix, Kevin Hrusovsky, **IBO** learned about the company (see Executive Briefing), including a soon-to-be-released new instrument.

The new instrument, the SR-Plex, primarily focuses on life science research in academia and pharma, allowing researchers to analyze blood at 1,000x greater sensitivity than ELISAs, in a benchtop format, with multiplexing capabilities to reduce sample costs. The instrument requires less sample than the firm's HD-1 Analyzer, which uses sample volumes of 50 µL. In contrast, the SR-Plex only requires a 35 µL sample volume, with an average cost per sample of $5–$15. With multiplexing, the per sample cost can be cut by a third to $1.60–$5 per sample. While the

HD-1 Analyzer costs between $160,000 and $160,500, Quanterix also plans to introduce the 25-plex system towards the end of 2019 at a price of $75,000. According to Mr. Hrusovsky, the company has already pre-sold all available instruments for 2018 and is looking to expand availability for new buyers.

Other vendors demonstrated technologies specifically related to providing better imaging solutions. ZEISS unveiled the next generation of its ZEISS EVO SEM. The last major refresh on the system was in 2013, although a new detector was added on in 2015. Some of the new significant features include a touchscreen/simplified user interface, a system scan to generate larger images, an integrated EDS workflow and a lanthanum hexaboride (LaB6) emitter allowing for highly stable emission images.

> *SEM technology allows 3D reconstruction of the brain with high resolution at faster speeds and covering larger volumes.*

One of the main differentiators of the EVO SEM as compared to competing SEMs is resolution, according to company representatives at SfN. In addition, its ease of use allows for novice users to quickly adapt to the instrument. A tablet-version interface allows for control of the instrument. According to the ZEISS team, an experienced customer stated he was even able to "train his novice daughter" on the instrument. As far as the SEM's contributions to neuroscience, the ZEISS team commented that SEM technology allows 3D reconstruction of the brain with high resolution at faster speeds and covering larger volumes.

Another vendor, Andor Technology, a division of Oxford Instruments, introduced the Dragonfly 200 high-speed confocal imaging platform. The Dragonfly platform is up to 20X faster than conventional confocal microscopes, according to an Andor representatives at SfN. Dragonfly 200 is smaller and lighter than the Dragonfly 500, and can be used in an upright position. Compared to other confocal microscopy systems, the company told **IBO** that Dragonfly 200 has a higher dynamic range, is comfortably operated at 400 frames per second at dual wavelength with low phototoxicity, and can image live cells or fixed cells in both clear and unclear tissue. The system is already shipping, and depending on the customer requirements, the systems sells for anywhere between $300,000 and $700,000.

Continuing the journey through microscopy-related product announcements at the show, Nikon released a new objective, the CFI90 20XC Glyc, for biological microscopes. The company prides itself on the objective providing large field of view (a distance of 90 mm), as well as high-resolution neural images across immersion media and tissue clearing agents. It also supports observation of large samples with an ultra-long working distance of 8.2 mm. According to Nikon, no other comparative product can provide close to the same working distance. The objective will begin shipping by the end of 2017.

Finally, MilliporeSigma introduced a new Stericup Quick Release system for improved cell culture filtration. It has been at least 10 years since the last update to the Stericup Sterile Vacuum Filtration System. The new, next generation system is designed to alleviate pain points experienced by lab scientists during sterile filtration processes. Although the membranes inside the filter remain the same, the redesign of the filter unit and the receiver bottle improves user experience with ergonomic enhancements to streamline the filtration process. The receiver bottle is offered in sizes 100–150 mL volumes with multiple membrane material and pore sizes. The main design enhancements include a quick-release filter funnel, which disconnects with only a quarter turn to help avoid spillage, a frosted side on the receiver bottle for ease in writing notations, and a slip-resistant lid that clicks into place. In addition, the receiver bottles are stackable, and the system also works with regular receiver bottle from the previous generation system.

Next year's SfN conference will be held November 3–7 in San Diego, California.

Sale of VWR Completed

Center Valley and Radnor, PA 11/21/17; Brussels, Belgium, 11/20/17—Avantor, a provider of ultra-high-purity materials, has completed its acquisition of VWR, which supplies product, supply chain and services solutions to lab and production customers (see **IBO** 5/15/17). The final purchase price totaled $6.5 billion. Avantor CEO Michael

Stubblefield will lead the combined company. "The completion of this acquisition marks the beginning of an exciting new chapter for our combined organization," he said. "The new Avantor is a leading global provider of discovery-to-delivery solutions that offer more value to customers along with an additional layer of supply chain security." VWR delisted from the NASDAQ stock change effective November 21. The EU announced the clearance of the transaction the day before the deal closed. The European Commission stated that "alternative manufacturers and distributors remaining on the market will be not be affected by the merger." (For VWR's latest quarterly financial results, see Bottom Line.)

According to a September article in the [Financial Times](#), *the purchase was delayed as investors requested a better return for the bond offering and loans, which together totaled $7.5 billion. Goldman Sachs increased the yields of the unsecured bond from 7.5% to 9%, as well as making other changes affecting the loans and the terms. Observers had criticized the buyout as overleveraged. The newspaper quotes a source as citing a debt-to-EBITDA ratio of 10 to 1 post closing. In September,* [Moody](#)*'s downgraded Avantor's Corporate Family Rating from B2 to B3 due to the acquisition's financing and integration, but noted positively the combined company's prospects for free cash flow and liquidity.*

Quanterix Prices IPO

Lexington, MA 11/27/17—Quanterix, a provider of an ultra-sensitive digital platform for life science and potentially diagnostics, has priced its IPO (see **IBO** 11/15/17) at $14–$16 per share. The stock will list on the NASDAQ stock exchange. The company stated it will use the net proceeds to expand operations, improve its technology, launch a new system (see [Conferences](#)), pursue regulatory approvals and potentially make acquisitions.

The IPO is expected to raise $61.5 million, according to the [Boston Business Journal](#)*. The company will offer 3,340,000 shares of common stock, with a 30-day option for underwriters to purchase up to an additional 501,000 shares, less the underwriting discount.*

GE Invests in Novel Bioprocessing Separation Technology

Chalfont, St. Giles, UK 11/28/17—GE Healthcare Life Sciences' BioProcess business has acquired Puridify for an undisclosed amount. Puridify's FibroSelect nano-scale single-use purification technology is designed to improve process development and small-scale manufacturing, with faster mass transfer, scalability and ease of use. Puridify has 17 employees based in the UK. GE stated that the technology complements bead resins and chromatography membranes for separations. "The technology that Puridify has been developing gives GE access to exciting technology that could give considerable improvements for some customers in their purification step. The early feedback from collaborators has been positive," said Jan Makela, general manager, BioProcess, GE Healthcare Life Sciences.

Utilizing a 3D matrix structure of cellulosic nanofibers, FibroSelect addresses the drawbacks with current bioprocess separation techniques, according to the company, providing a fast flow rate and increase flexibility resulting in higher productivity. GE joins the list of bioprocess tool companies adding single-use technologies for downstream separations, including Pall (see **IBO** *4/15/15) and MilliporeSigma (see* **IBO** *8/31/17).*

Metrohm Expands Raman Offerings

Herisau, Switzerland 11/16/17—Metrohm's Metrohm Raman subsidiary has acquired Diagnostic anSERS. Diagnostic anSERS' low-cost SERS (Surface-Enhanced Raman Scattering) substrates to provide a solution for field detection of trace analytes. "The P-SERS platform is perfect for detection of nonvisible amounts of materials that are

undetectable without SERS enhancement," stated Metrohm Raman CEO Dr. Keith Carron. Metrohm will begin selling the SERS substrates in early 2018 when it releases the Mira DA in early 2018.

SERS enhances a Raman signal by using a metal substrate, enabling measurement of materials at low concentration. Advantages of Diagnostic anSERS' substrates are their single use, low cost and physical flexibility. Field applications include drug testing and food testing. Among other companies providing SERS solutions are HORIBA and Ocean Optics.

Southeast Asian Lab Product–Distributor Purchased

Singapore, 11/23/17—Private equity firm the Everstone Group's Everlife platform has purchased Malaysia-based Chemopharm. Chemopharma distributes medical products and solutions, including lab equipment, to over four thousand customers in Singapore, Thailand, Indonesia, Vietnam and the Philippines. The firm represents more than 50 manufacturers. "I recognize the tremendous value that Chemopharm and its executive team bring to Everlife in what will be an exciting journey of scaling the platform in existing and new geographies and into new product segments," commented Troy Bailey, who along with Dr. Amit Kakar, will lead Everlife. Chemopharm Founder and CEO C A Ooi will maintain his role, as well as Chemopharm leadership.

Chemopharma distributes lab equipment and systems as well as manufactures lab furniture, according to an Everstone spokesperson. Discussing how Everlife plans to grow its lab equipment business, the Everstone spokesperson said, "Everlife is building one of the largest platforms across the region with multiple other acquisitions and access to many principals who are keen to have access across the region."

Third Quarter Results: Agilent, Bio-Techne, Bruker, Hitachi High-Technologies, Nanostring

CY Q3 2017 Results								
	Revenues			Rev. Growth Summary			Adj. Operating Profit	
Company	Rev. ($M)	% of Co. Rev.	Growth	Curr.	Acq./Div.	Org. Growth	($M)	% Growth
Agilent Technologies	$1,189.0	100%	7.0%	1%	0%	6%	$277.0	10.8%
Bio-Techne	$144.6	100%	10.7%	1%	2%	8%	$51.0	7.4%
Bruker Scientific Instruments	$390.6	90%	8.0%	2%	2%	4%	$57.0	1.8%
Hitachi High-Tech. (Sci. & Med. Sys.)	¥87,500.0	26%	-5.3%	0%	0%	-5%	¥9,700.0	-33.1%
Nanostring Technologies	$27.0	100%	12.9%	0%	0%	12%	-$10.0	-18.6%

Click to enlarge

Strong Finish to Fiscal Year for Agilent Technologies

Fiscal fourth quarter sales for Agilent Technologies rose 7.1% to $1.19 billion, driven by strong growth across all businesses and major geographies. Acquisitions and currency effects collectively added 1.3% to overall sales growth. Organically, sales increased 5.8%, beating the company's estimate of 3.5%.

Agilent Technologies Q4 FY17				
	Rev. ($M)	% of Rev.	% Rev. Growth	Org. Growth
Life Sciences & Applied Markets	$575.0	48%	4.9%	3.8%
Agilent CrossLab	$404.0	34%	9.2%	7.8%
Diagnostics & Genomics	$210.0	18%	8.8%	6.7%

Agilent Technologies FYE 17			
	Rev. ($M)	% of Rev.	% Rev. Growth
Life Sciences & Applied Markets	$2,169.0	48.0%	4.6%
Agilent CrossLab	$1,531.0	34.0%	7.8%
Diagnostics & Genomics	$772.0	18.0%	8.9%

By end market, in the Analytical Laboratory group, Chemical and Energy sales rose 15%, driven by broad-based growth across major regions as well as sales for exploration, refining and chemicals. Academia and Government sales grew 12%, beating company expectations. Sales growth was driven by strong demand in Europe and the Americas, with strength across most product lines. Sales in the Food end-market advanced 10% for the quarter, propelled by services, consumables and mass spec sales. Additionally, continued success in Europe and Asia further added to overall Food sales. Environmental and Forensics revenue grew modestly, up 4%, driven by increasing concerns about environmental health in Asia, particularly China. Higher demand for GC, GC/MS and ICP-MS also contributed to the end-market's sales. Pharma and Biotech sales, however, fell 5% due to a decline in the Nucleic Acid Solutions Division (NASD) and a tough prior year comparison. In the Diagnostics and Clinical group, sales increased by 9%, supported by strong pathology and companion diagnostics sales.

Agilent Revenue by Region Q4 FY17
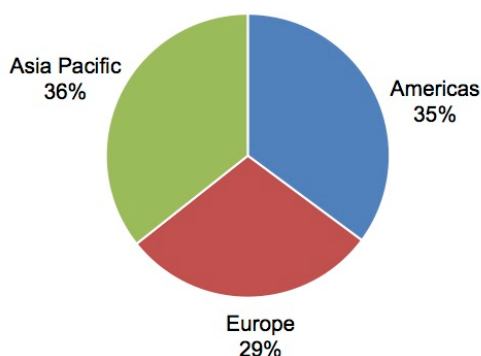
For the quarter, Agilent's Life Sciences & Applied Markets (LSAG) segment revenue grew 4.9%, 3.8% organically, to $575.0 million, led by the Chemical and Energy, Academia and Government, and Food end-markets. Double-digit growth in MS, microfluidics and cell analysis platforms contributed to segment growth. Operating margin for the segment increased 1.2 percentage points to 24.0%, as operating profit experienced double-digit growth of 10.4% to reach $138.0 million. For the year, LSAG sales rose 4.6% to $2,169.0 million, while operating profit advanced 13.5% to $487.0 million.

Agilent Revenue Breakdown Q4 FY17
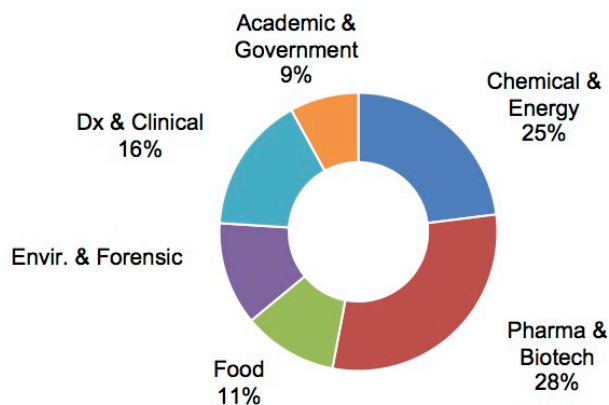
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Agilent CrossLab (ACG) sales for the quarter increased 9.2% to $404.0 million. Organically, sales grew 7.8%, driven by service and consumables sales. Additionally, most regions and end-markets performed well. ACG's operating profit grew 9.5% to $92.0 million, representing a 22.9% operating margin, up 20 basis points. For the fiscal year, segment sales climbed 7.8% to $1,531.0 million to account for 34% of total company revenues. ACG's chemistry business also contributed to full-year segment sales, experiencing double-digit growth in its AdvancedBio column portfolio. Operating profit for the fiscal year grew 7.0% to $338.0 million.

Revenue for the Diagnostics and Genomics segment (DGG) amounted to $210.0 million for the quarter. Sales increased 8.8%, 6.7% organically, due to increased demand for pathology and molecular products, as well as continued strength for PD-L1 sales. Segment operating margin increased 120 basis points to 20.8%, while operating profit grew 15.8% to $44.0 million. For the year, DGG sales advanced 8.9% to $772.0 million as operating profit vaulted 30.7% to $149.0 million.

Geographically, sales in the Asia Pacific region accounted for 36% of total quarterly company revenues, driven by China's strong performance. Sales in China were $233.0 million, a 6.9% increase, while sales in the rest of the Asia Pacific region grew 4.0%. Altogether, Asia Pacific sales climbed 3.7% to $424.0 million. Sales in the Americas also experienced healthy gains, as revenue increased 5.5% to $418.0 million, representing 35% of total company sales. European sales accounted for 29% of company sales, growing 13.4% in the fourth quarter to reach $347.0 million. For the full year, sales in the Asia Pacific accounted for 37%, the Americas for 34%, and in Europe for 29% of total company sales.

For the first quarter of fiscal year 2018, Agilent expects revenues to be between $1.145 billion and $1.165 billion, representing 5.3% organic growth. For full-year 2018, the company projects revenues to range from $4.72 billion to $4.74 billion. Organically, full-year revenue growth is expected to be 4.0%–4.5%. By end-market, Agilent forecasts revenue growth for Academia and Government to be 3%. Environmental and Forensics sales are also expected to grow around 3%. Chemical and Energy sales growth is projected to be 5%, while Pharma sales are expected to be between 4% and 5%. Diagnostics and Clinical sales growth is anticipated to rise 6%.

Overall Growth Propels Bio-Techne Through First Quarter

Bio-Techne's fiscal 2018 first quarter sales increased 10.7% on a reported basis to $144.6 million. Organically, sales grew 8.0% as currency effects and acquisitions added 1% and 2% to growth, respectively. Sales growth for the quarter was heavily driven by the company's two primary life science segments, Biotechnology and Protein Platforms, for which organic growth amounted to 9% collectively.

Bio-Techne Q1 FY2018			
	Rev. ($M)	% of Rev.	% Rev. Growth
Biotechnology	$95.1	66%	9.6%
Diagnostics	$25.0	17%	3.1%
Protein Platforms	$24.6	17%	25.9%

Click to enlarge

Biotechnology sales advanced 9.6% to $95.1 million, representing 66% of total company revenues. Organically, sales rose 6.0%, with 3% growth from acquisitions and 1% growth due to favorable currency effects. Sales for the segment were driven by strong antibody revenue growth and Advanced Cell Diagnostics (ACD) sales. Antibody sales were largely boosted by a 30% increase in Novus brand revenue, along with high-single digit sales for the R&D System brand. ACD sales also experienced significant growth, vaulting more than 40% due to increasing demand for its RNA-ISH technology. Additionally, sales of the company's multiplex assays increased by around 25.0%. Adjusted operating margin fell 2.0 percentage points to 46.9% due to recent acquisitional costs of ACD.

Diagnostics revenue increased modestly by 3.1% to $25.0 million, supported by mid-single digit sales growth in hematology and glucose-based controls. Unfavorable timing of orders from consumers, along with a difficult prior year comparison, partially offset those gains. Adjusted operating margin for the quarter fell 2.7 percentage points due to lower margin mix of product sales. Segment revenue accounted for around 17% of total company sales.

Revenue for Protein Platforms soared 25.9% to $24.6 million, representing 17% of total company sales. Organically, sales rose 25.0%, with 1% growth coming from favorable currency effects. Segment sales growth increased by double-digits for the seventh consecutive quarter. The segment's strong performance was driven primarily by its major product categories, Biologics, Simple Western, Simple Plex and Single-Cell Western. Simple Western and Simple Plex sales grew more than 20% and 100%, respectively. Adjusted operating margin for the segment surged 11.3 percentage points to 12.4%.

Geographically, the US accounted for the largest portion of the company's sales at 56%. US sales grew in the mid-single digits, driven by the academic and biopharmaceutical end-markets. The biopharmaceutical market boosted the US' robust sales and provided even more growth to the European region's sales. EMEA sales accounted for 27% of total company sales, driven by Europe's strong double-digit organic growth. EMEA's organic growth reached the low teens due to broad-based success, with particularly strong sales for the company's reagents and instrument product categories. Within Europe, most of the major countries' sales growth advanced in both the academic and biopharmaceutical end-markets.

In Asia Pacific, sales represented about 14% of total company revenues, driven by China and South Korea's strong performance. Overall APAC sales leaped nearly 30% for the quarter, for which China's sales grew around 20% organically, propelled by the company's Western brands, for which sales grew over 30%. Japan similarly advanced, with double-digit organic growth for the quarter.

For the remainder of fiscal 2018, Bio-Techne expects organic growth to be around 8%.

Solid Third Quarter for Bruker Scientific Spurs Guidance Upgrade

Bruker's revenues for the third quarter totaled $435.6 million, an increase of 10.6% on a reported basis. Currency effects, along with acquisitions, added 2.4% and 4.8% to overall sales growth, respectively. Organically, sales grew 3.4%, driven by improved academic, governmental, industrial and semiconductor metrology (semi) end-markets. Operating profit increased 8.7% to $49.9 million, while operating margin fell 20 basis points to 11.45%.

Bruker Q3 FY17						
	Rev. ($M)	% of Rev.	% Rev. Growth	Currency	Acq./ Div.	Org. Growth
Bruker Scientific Instruments	$390.6	90%	8.0%	1.8%	2.0%	4.2%

Click to enlarge

Geographically, Europe accounted for 35% of total company sales, driven by mid-teens organic growth. Academic and industrial end-market sales in Europe continued to recover, supported by an improving European economy. The Americas represented 31% of total company sales, growing in the mid-single digits. APAC sales fell slightly due to a weak performance in Bruker's BEST segment, along with a significant decline in Japanese sales. However, sales in China were up double digits, driven by increased funding and disbursements for research and applications.

Bruker Revenue Year to Date 2017
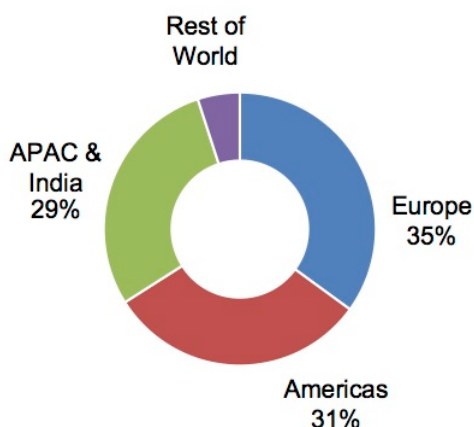
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Bruker Scientific Instruments (BSI) segment revenue advanced 8.0% to $390.6 million, driven by continued strength in biopharma and microbiology revenue growth. Excluding acquisitions that added 1.8% growth and currency effects that added 2.0% growth, organic growth amounted to 4.2%. The segment's operating profit remained relatively flat, falling just half a percent to $43.1 million. Operating margin fell 95 basis points to 11.0%. Overall, segment sales represented about 90% of total company revenue.

BSI's BioSpin group's revenue growth remained flat, supported by sales of low-field NMR systems. Pre-clinical imaging sales experienced a continued recovery. Similarly, BioSpin's aftermarket and service sales continued to grow, as both were up low double digits.

Revenue for the CALID group increased mid-single digits, driven by strong MS sales to academic and clinical consumers. Both Daltonics and Optics products experienced significant revenue growth, supported by improved demand in the applied and industrial markets. InVivo, acquired earlier this year (see ***IBO*** 1/15/17), also added strong consumables sales growth to CALID's revenue. CALID's Detection sales, however, fell due to weakened demand along with a tough prior-year comparison.

Bruker NANO group's sales rose high single digits, propelled by semiconductor revenue. Recently acquired Hysitron (see ***IBO*** 2/1/17) also added to group revenue with solid nanoindenting product sales. Similarly, AXS sales also added to the group's overall revenue, driven by an improved European market and faster industrial growth. Overall, improved industrial end-market growth contributed to NANO's strong quarterly performance.

For the year, Bruker expects its total revenue growth to be 8%-8.5%, an upgrade from the previous guidance of 4.5%–6.0%. Acquisitions are expected to add 4.5% to sales growth, while currency effects are projected to contribute about 1.0%. Organically, the company projects revenue to grow between 2.5% and 3.0%, up from the previously projected 1.5%–2.0%.

SMS Sales Continue to Slip for Hitachi High-Technologies

Hitachi High-Technologies' Science and Medical Systems (SMS) first-half results were unfavorable as sales fell 5.3% to ¥87.5 billion ($780 million at ¥111.7 = $1). However, despite falling short on a year-over-year basis, SMS sales still exceeded company expectations of ¥84.6 billion ($760 million). SMS operating profit for the half decreased 33.0% to 9.7 ¥billion ($90 million), again beating the company's own expectation of ¥8.1 billion ($70 million).

Hitachi High-Technologies Science & Medical Systems H1 FY18	Rev. (¥B)	% Rev. Growth	% of Rev.
Electron Microscopes	¥15.8	14.5%	18%
Scientific Instruments	¥12.9	20.6%	15%
Medical Products	¥49.8	-18.8%	57%
Biotechnology Products & Other	¥9.0	36.4%	10%

Click to enlarge

Electron Microscope revenue increased 14.5% to ¥15.8 billion ($140 million), driven by strong demand in Asia and Europe. However, electron microscope demand in Japan remained flat. Scientific Instruments sales leaped 20.6% to ¥12.9 billion ($120 million), primarily due to a recovery in demand for analyzers. Electron Microscope and Scientific Instrument sales accounted for 18% and 15% of SMS sales, respectively.

Hitachi SMS Revenue H1 FY18
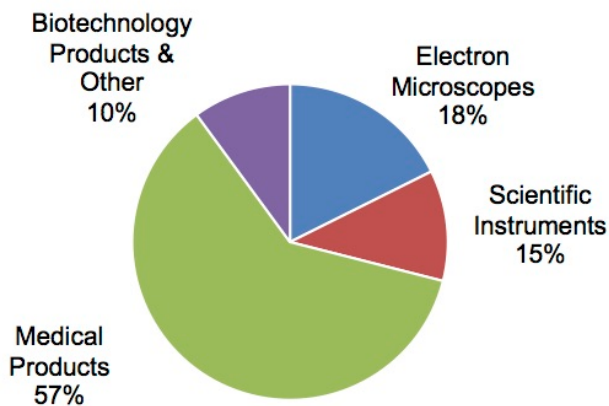
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The Biotechnology and Medical segments overall experienced strong sales of immunodiagnostic analyzers and clinical chemistry, driven by growth in China. Sales for Biotechnology Products alone vaulted 36.4% to ¥9.0 billion ($80 million), accounting for 10% of total SMS sales. Medical Products revenue fell 18.8% to ¥49.8 billion ($450 million), still representing the largest amount of SMS sales at 57%.

Geographically, overall company sales remained largely dependent on Asia, where sales accounted for 40% of total revenues. Sales in Asia advanced 23.6% to ¥134.1 billion ($1.2 billion), driven by strong sales growth in China, while sales in Japan grew 8.9% to ¥126.3 billion ($1.13 billion). Conversely, both North America and Europe experienced a decrease in sales, falling 13.3% and 14.4% to ¥25.4 billion ($230 million) and ¥39.3 billion ($350 million), respectively. Sales in Other regions of the world totaled ¥10.4 billion and accounted for 3% of total company sales.

For the full fiscal year 2018, Hitachi High-Technologies expects SMS sales to be ¥188.5 billion ($1.69 billion), a

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decrease from the previously projected ¥190.5 billion ($1.71 billion).

## Collaborations Drive Third Quarter Sales for Nanostring

Third quarter revenues for Nanostring Technologies advanced 12.9% to $27.0 million, driven by Collaborations and Prosigna (IVD) sales growth. Product and services revenue fell 11.7% to $16.9 million due to weak instrument and consumable sales.

NanoString Technologies Q3 FY17			
	Rev. ($M)	% Rev. Growth	% of Total Rev.
Instruments	$4.4	-35.6%	16%
Consumables	$9.0	-12.5%	33%
In Vitro Diagnostics	$1.7	47.3%	6%
Service	$1.8	115.1%	7%
Collaborations	$10.1	111.9%	37%

Click to enlarge

Instrument sales declined 35.6% to $4.4 million primarily due to a significant cutback in systems sold. Segment sales were further impacted by weak academic sales, lowering instrument system placements worldwide by 40%. Service revenue increased dramatically for the quarter due to an increase in the number of instruments covered by service agreements. Collaborations revenue experienced significant growth as well, advancing 111.9% to $10.1 million, largely driven by increased revenue from the Merck and Lam collaborations.
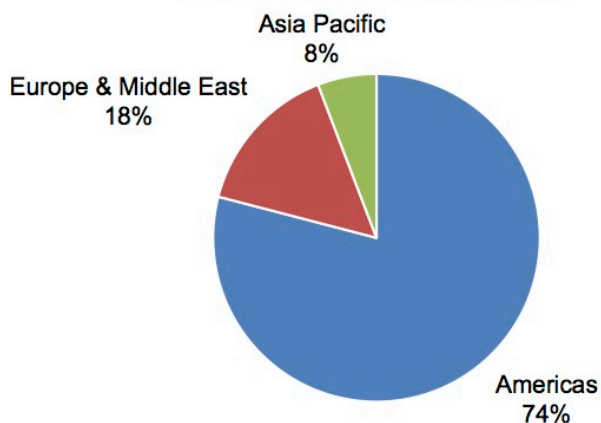
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Consumables sales excluding IVD sales decreased, dipping 12.5% to $9.0 million. The contraction in sales was due to a large reduction in consumables sales to biopharmaceutical and academic end-users. However, IVD sales advanced 47.3% to $1.7 million, partially offsetting the negative consumables sales. Together, overall consumables revenue decreased 6.5% to $10.7 million to account for approximately 40% of total company revenues.

Geographically, sales in the Americas remained robust, advancing 19.5% to $20.0 million. Sales were supported by increased demand in the US and South America, especially for IVD. In Europe and the Middle East, sales were relatively flat, dropping just half a percent to $4,911.0 million. Sales in Asia Pacific experienced a 7.6% decline, decreasing to $2,045.0 million due to weak instrument and consumable sales.

For the full year, Nanostring expects its product and service revenue to be $68–$71 million, a downgrade from the previous projection of $81–$85 million. Gross margin for Product and Services is now expected to be 56%, versus the previous guidance of 57%–58%. Operating loss is expected to be between $38 and $41 million. Overall company sales are projected to total $109–$112 million, a decrease from the previous guidance of $114–$118 due to lower-than-expected third quarter results. The new guidance signifies revenue growth of 26%.

IBO Stock Indexes: Lab Instrumentation Stock Index Up Double Digits in November

US Federal Reserve Chairwoman Janet Yellen announced her resignation on Monday, November 27, and it is expected to be effective as of February 2018. But her resignation is expected to have little impact, as Fed policymakers are still on track to raise interest rates in December, the third time this year. Estimates released this month show US GDP increased 3.3% for the third quarter, up 20 basis points sequentially. The better-than-expected GDP rate was primarily driven by increased exports, private inventory investments and nonresidential fixed investments.

The Dow Jones Industrial Average (DJIA) climbed 3.8% in November to close at 24,272.35, and also represented an 895.11-point sequential increase. Year to date, the DJIA has increased 22.8%. The S&P 500 increased 2.8% to end at 2,647.58 for the month, representing sequential growth of 72.32 points. The NASDAQ Composite rose 2.2% to finish the month at 6,873.97.
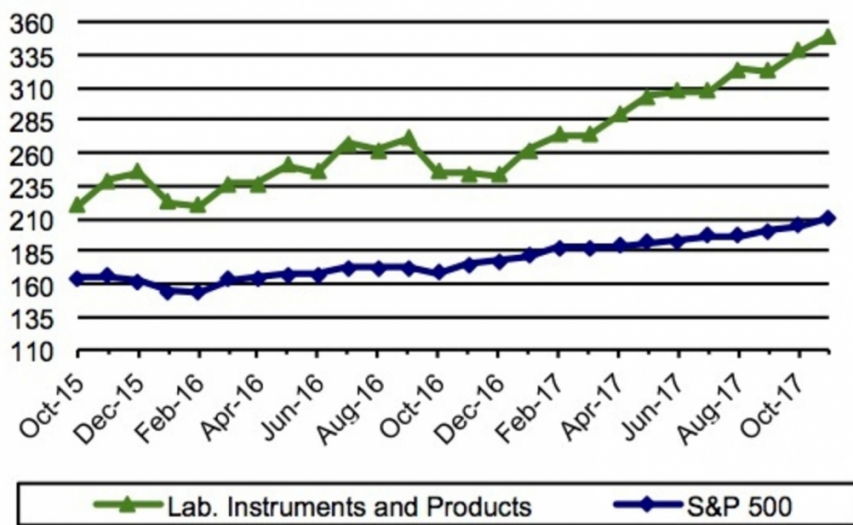
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Laboratory Instrumentation Stock Index

The *Laboratory Instrumentation Index* advanced 3.2% to 349.01 in November. The *Index*'s top performer was **Bio-Rad Laboratories**, increasing 23.4% to close at $271.30. Conversely, **Pacific Biosciences** fell 24.6% to $3.19. **Nanostring Technologies'** shares also fell double digits, decreasing 23.2% to close at $7.65. The stock has also also fallen the most year to date among *Index* stocks, having dropped 65.7%.

Year to date, **Illumina**'s share prices have increased the most, leaping 79.7% to end the month at $230.03. Illumina shares also experienced solid double-digit growth for the month, increasing 12.1% to $230.03.

For the month, **Agilent Technologies'** share price increased slightly, up 1.8% to finish the month at $69.24. The company reported fiscal fourth quarter earnings on November 20 (see Bottom Line). Net income totaled $177.7 million, representing an EPS of $0.54. Adjusted EPS for the quarter, $0.67, beat company expectations of $0.61 and even beat analysts' projections of $0.63. On November 21, Deutsche Bank set a price target for the stock of $75.00, along with a "buy" rating. For the fiscal first quarter, Agilent expects its adjusted EPS to be $0.55–$0.57. As for fiscal year 2018, the company projects an adjusted EPS of $2.50–$2.56. On November 15, Agilent increased its cash dividend from 13.2 cents per share to 14.9 cents.

Also reporting this month was **Becton**, **Dickinson**. The company released its fiscal year-end earnings on November 2, delivering adjusted EPS of $9.48. For the quarter, adjusted EPS beat analysts' expectations by $0.02, reaching $2.40. The company's share price advanced 9.4% to $228.21 for the month. On November 3, Morgan Stanley upgraded the stock's price target from $205.00 to $245.00. As for fiscal 2018, the company expects adjusted EPS to range between $10.55 and $10.65, representing growth of around 12%.

Third quarter earnings for **Bio-Rad Technologies** were reported on November 7. The company delivered adjusted EPS of $0.91, surpassing analysts' expectations of $0.33 and increasing 46.8% from the same period last year. The significant increase in earnings was supported by lower SG&A expenses. Bio-Rad also announced a new share repurchase program of up to $250 million on November 28. On November 29, Wells Fargo gave the stock an "outperform" rating, along with a $290.00 price target. Overall, share prices jumped 23.4% for the month.

Bruker also beat analysts' forecasts. The company reported third quarter earnings on November 1, recording adjusted EPS of $0.29. Adjusted EPS beat analysts' expectations of $0.27 but fell 9.4% from the same period last year. The company expects its full-year adjusted EPS to be $1.17–$1.20. On November 3, Citigroup upgraded the stock's price target from $29.00 to $34.00. For the month, Bruker's share price increased 12.0% to end at $134.75.

Other companies reported net losses this quarter. **Fluidigm** shares rose 2.6% for November despite reporting net losses for the quarter. On November 2, the company announced its third quarter adjusted EPS increased 34.2% to -$0.25. **Nanostring Technologies** also experienced negative adjusted EPS, -$0.45, for the quarter. On November 3, Robert W. Baird downgraded the stock's price target from $14.00 to $12.00. The company expects its full-year net loss per share to be between $1.86 and $1.99, an upgrade from the previously projected loss of $2.03–$2.20.

Larger companies remained on track. On November 2, **Mettler-Toledo** reported third quarter adjusted EPS of $4.36, an increase of 12.1%. The company's strong adjusted EPS growth was driven by solid sales growth in its Lab and Industrial businesses as well as increased productivity. On November 3, Morgan Stanley upgraded the stock's price target from $535.00 to $545.00. Mettler-Toledo stock price, however, fell 7.8% for the month, closing at $629.21. The company expects its adjusted EPS to increase by around 18%, yielding $17.50, an upgrade from the previously projected $17.25–$17.35.

However, share prices dropped for two life science companies this month. **Pacific Biosciences** recorded third quarter earnings on November 1, in which net loss totaled $22.0 million, a further increase from last year's third quarter loss of $17.5 million. Adjusted EPS remained flat at -$0.19. Share prices for the month dropped 24.6% to $3.19.

Third quarter earnings for **PerkinElmer** were announced on November 6. Adjusted net income for the period amounted to $554.5 million, an increase of 7.7%. Adjusted EPS increased 7.4% to $0.73, beating analysts' expectations of $0.72. For the full year, PerkinElmer expects adjusted EPS to be between $2.87 and $2.89. On November 3, Morgan Stanley upgraded the stock's price target from $77.00 to $78.00. Stock price grew 1.9% to $73.68 for the month and is up 41.3% year to date.

On November 6, **QIAGEN** reported third quarter net income of $48.5 million, an increase of 39.3%. Adjusted EPS for the quarter rose 6.7% to $0.32, which fell in line with analysts' expectations. On November 8, Deutsche Bank reiterated its "buy" rating for the stock. However, share prices fell 5.8% for the month, closing at $31.90.

Company	Date Rep.	Fiscal Quarter	2017 Adj. EPS	Analyst Consensus	Vs. Estimate		YOY Growth	2016 Adj. EPS
Laboratory Instruments and Products Stock Index								
A	20-Nov	Q4	$0.67	$0.63	⬆	$0.04	13.6%	$0.59
BDX	2-Nov	Q4	$2.40	$2.38	⬆	$0.02	13.2%	$2.12
BIO	7-Nov	Q3	$0.91	$0.33	⬆	$0.58	46.8%	$0.62
BRKR	1-Nov	Q3	$0.29	$0.27	⬆	$0.02	-9.4%	$0.32
FLDM	2-Nov	Q3	($0.25)	($0.37)	⬆	$0.12	34.2%	($0.38)
MTD	2-Nov	Q3	$4.36	$4.30	⬆	$0.06	12.1%	$3.89
NSTG	1-Nov	Q3	($0.45)	($0.57)	⬆	$0.12	11.8%	($0.51)
PACB	1-Nov	Q3	($0.19)	($0.20)	⬆	$0.01	0.0%	($0.19)
PKI	6-Nov	Q3	$0.73	$0.72	⬆	$0.01	7.4%	$0.68
QGEN	6-Nov	Q3	$0.32	$0.32	⮕	$0.00	6.7%	$0.30
Diversified Laboratory Stock Index								
AME	7-Nov	Q3	$0.66	$0.62	⬆	$0.04	17.9%	$0.56
TDY	2-Nov	Q3	$1.90	$1.57	⬆	$0.33	25.0%	$1.52

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Diversified Instrumentation Stock Index

For November, the *Diversified Instrumentation Index* rose 6.0% to 276.33. All companies' share prices in the grew for the month, with **Teledyne Technologies** increasing the most at 9.6%. Conversely, **Danaher** shares experienced the least amount of growth at 2.3%. Overall, *Index* companies' share prices increased in the mid- to high-single digits.

AMETEK share prices rose 7.7% to $72.69 for the month. Year to date, the company's share price has advanced 49.6%. On November 7, AMETEK reported its third quarter earnings, delivering adjusted EPS of $0.66, an increase of 17.9%. Adjusted EPS also beat analysts' expectations of $0.62, driven by strong organic sales growth and acquisitions. As such, the company raised its full-year guidance to $2.57–$2.58 from $2.46–$2.52. For the fourth quarter, AMETEK expects adjusted EPS of $0.66–$0.67, similar to this quarter. The company also announced quarterly dividends of $0.09 for the fourth quarter

On November 2, **Teledyne Technologies** announced net income of $69.0 million for the third quarter, an increase of 32.7%. The company's adjusted EPS increased 25.0% to $1.90, surpassing analysts' expectations of $1.57. As such, Teledyne raised its full-year adjusted EPS guidance from $6.15–$6.25 to $6.66–$6.71. In line with the good news, its share price for the month advanced 9.6% to close at $186.24.

International Stock Index

Asia Pacific indexes in **IBO** Stock Table all finished the month in positive territory, with the exception of Malaysia's KLCI, which fell 0.4% to 1,717.86. Asia Pacific's top gaining index was Japan's Nikkei 225, rising 8.1% to 22,724.96. Following it was India's Sensex 30, which increased 6.2% to 33,149.35. Overall, Asia Pacific indexes rose by mid-single digits.

Asian Pacific companies in **IBO's** Stock Table ended November mostly in positive territory. **Shimadzu**'s share price gained 14.0% to close the month at ¥2,677 ($23.77 at ¥112 = $1), while **JEOL's** share prices also experienced strong growth, advancing 9.7% to ¥656 ($5.83). But Japan's **Hitachi High-Technologies** and **Precision System Science,** and Hong Kong's **Techcomp** fell 1.5%, 0.6% and 3.8% for the month, respectively.

European equity markets in the *Index* ended on positive ground as well, with France's CAC and Germany's XETRA DAX growing the fastest. Both indexes grew near mid-single digits, at 3.3% and 3.1%, respectively. Gaining the least was Italy's FTSE MIB and Switzerland's SMI, up 0.4% and 0.9%, respectively. Overall, European indexes grew in

low single digits.

The majority of the European shares in the **IBO** *Stock Table* finished the month in negative territory. Among UK stocks, **Oxford Instruments** fell the most, decreasing 7.1% to £8.83 ($11.95 at £0.74 = $1). Conversely, **Scientific Digital Imaging's** share price grew the fastest, increasing 12.3% to £0.24 ($0.32). European shares in the *Index* outside the UK similarly experienced decreases, with only **Biotage** gaining 3.0% to close the month at SEK 76.75 ($9.16 at SEK 8.38 = $1).

Company: Exchange	Market Value (US M)	52 Week Range Low ($)	52 Week Range High ($)	Price 11/30/17	Change 1 Month	Change YTD	P/E (ttm)	EPS (ttm)
Laboratory Instruments and Products								
Agilent Technologies: n	$20,865	42.92	61.84	$69.24	1.8%	52.0%	36	1.94
Becton, Dickinson and Company: n	$42,691	161.29	206.63	$228.21	9.4%	37.8%	50	4.60
Bio-Rad Laboratories: n	$6,647	143.39	239.91	$271.30	23.4%	48.8%	343	0.79
Bio-Techne: o	$4,533	95.68	117.42	$134.75	2.8%	31.0%	69	1.95
Bruker: o	$4,775	19.59	27.85	$35.18	12.0%	66.1%	37	0.94
Enzo Biochem: n	$485	4.88	9.68	$9.81	-0.4%	41.4%	NM	-0.05
Fluidigm: o	$147	4.31	11.05	$5.95	2.6%	-18.3%	NM	-2.22
Harvard Bioscience: o	$130	2.25	3.90	$3.30	-1.5%	8.2%	NM	-0.09
Illumina: o	$29,282	119.37	189.48	$230.03	12.1%	79.7%	44	5.25
Kewaunee Scientific: o	$81	16.38	27.60	$27.55	-3.3%	12.7%	17	1.60
Luminex: o	$874	17.64	23.75	$21.36	0.0%	5.6%	32	0.66
Mettler-Toledo: n	$16,651	343.61	582.20	$629.21	-7.8%	50.3%	38	16.45
MTS Systems: o	$1,021	41.53	59.00	$55.90	7.4%	-1.4%	44	1.27
NanoString Technologies: o	$349	11.89	23.45	$7.65	-23.2%	-65.7%	NM	-2.05
Pacific Biosciences: o	$488	3.46	10.40	$3.19	-24.6%	-16.1%	NM	-0.90
PerkinElmer: n	$7,602	45.35	63.03	$73.68	1.9%	41.3%	20	3.60
QIAGEN: o	$7,399	20.73	33.06	$31.90	-5.8%	13.8%	100	0.32
Thermo Fisher Scientific: n	$74,564	139.07	173.64	$192.76	-0.6%	36.6%	33	5.88
VWR: o	$4,371	24.42	37.25	$33.11	0.0%	32.3%	31	1.08
Waters: n	$14,496	131.35	179.07	$197.17	0.6%	46.7%	29	6.78
Diversified Laboratory								
AMETEK: n	$15,253	43.28	61.37	$72.69	7.7%	49.6%	31	2.38
Corning: o	$27,996	18.88	29.72	$32.39	3.4%	33.5%	14	2.31
Danaher: n	$60,528	73.42	88.01	$94.36	2.3%	21.2%	28	3.38
Honeywell	$108,185	105.25	135.00	$155.96	8.2%	34.6%	24	6.60
Illinois Tool Works: n	$51,642	98.32	142.82	$169.25	8.1%	38.2%	26	6.52
Roper Technologies: n	$25,097	159.28	228.21	$267.21	3.5%	46.0%	39	6.89
Teledyne Technologies: n	$5,747	92.52	137.00	$186.24	9.6%	51.4%	32	5.88
Xylem: n	$11,317	42.52	54.99	$69.34	4.2%	40.0%	40	1.72
Laboratory Instruments and Products				349.01	3.1%	43.6%	62	
Diversified Laboratory				276.33	6.0%	34.4%	29	
Dow Jones Industrial Average				24,272.35	3.8%	22.8%		
S&P 500				2,647.58	2.8%	18.3%		
NASDAQ Composite				6,873.97	2.2%	27.7%		

Region Company	Market Value (Local M)	52 Week Range Low (L)	52 Week Range High (L)	Price 11/30/17	Change 1 Month	Change YTD	P/E (ttm)	EPS (ttm)
Pacific Shares								
GL Sciences: t	¥17,076	557	1,494	¥2,116	4.8%	139.1%	15	¥144.19
Hitachi High-Technologies: t	¥540,625	3,360	5,040	¥4,645	-1.5%	-1.5%	19	¥245.97
HORIBA: t	¥286,671	4,305	7,440	¥7,000	4.3%	29.4%	19	¥375.69
JEOL: t	¥50,714	356	648	¥656	9.7%	28.6%	91	¥7.21
Precision System Science: os	¥13,077	334	1,011	¥671	-0.6%	64.9%	NA	-¥71.44
Shimadzu: t	¥598,358	1,394	2,254	¥2,677	14.0%	43.8%	31	¥87.56
Techcomp: hk	HKD 521	1.07	3.21	HKD 1.79	-3.8%	38.8%	23	¥0.01
European Shares (London)								
Abcam: l	£2,168	7.14	10.34	£9.83	-1.2%	28.2%	47	£0.21
Halma: l	£4,144	8.79	11.82	£12.80	8.3%	42.6%	37	£0.34
Horizon Discovery: l	£231	1.05	2.71	£2.40	-6.3%	66.7%	NA	-£0.12
Oxford Instruments: l	£601	6.10	11.39	£8.83	-7.1%	20.6%	NA	-£0.44
Scientific Digital Imaging: l	£22	0.13	0.31	£0.24	12.3%	29.7%	21	£0.01
Spectris: l	£2,757	18.40	28.69	£25.04	-2.2%	8.3%	93	£0.27
European Shares (Other)								
Biotage: st	SEK 3,818	33.90	67.50	SEK 76.75	3.0%	67.2%	42	SEK 1.83
Datacolor: s	CHF 124	538.00	800.00	CHF 890.00	-1.1%	36.9%	22	CHF 41.39
Merck KGaA: g	€ 11,946	88.20	115.20	€ 89.64	-2.8%	-9.6%	24	€ 3.68
Sartorius: g	€ 6,028	65.01	90.12	€ 76.67	-0.1%	5.3%	45	€ 1.70
Tecan: s	CHF 2,159	148.80	187.30	CHF 202.70	-3.9%	27.6%	42	CHF 4.84

The *IBO Stock Indexes* are weighted by marked capitalization. The *Indexes'* averages for the financial ratios presented are also weighted statistically to reflect the relative sizes of the constituent companies. *Laboratory Instruments and Products Index*: 12/30/11 = 100. *Diversified Laboratory Index*: 12/30/11 = 100. Exchanges: n = NYSE; o = NASDAQ; t = Tokyo; hk = Hong Kong; l = London; g = Germany; s = Switzerland; st = Sweden; no = Nordic Market; os = Osaka Securities. N/A = not available; NM = not meaningful.

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Micro GC

As the name implies, a micro (or portable) GC is a compact and often mobile GC. They have become popular in recent years as an alternative to standard laboratory GCs in applications where research-grade results are not necessary, thus paving the way for reduced measurement times, and cheaper installation and maintenance. Micro GCs are generally used for niche applications where speed and field use are important, most notably in the oil and gas industry. They are useful for quick evaluation of petroleum stock and for process control in refining or gas processing facilities.

In a standard GC, an analyte is injected with a micro syringe into an inlet system with a temperature high enough to ensure the sample is in a gaseous form, if it is not already. An inert carrier gas, often helium but sometimes hydrogen or nitrogen, carries the analyte through a long column coated with a solid absorbent. As the sample travels through the column, its various chemical components are separated on the basis of their interactions with the absorbent on the column. The nature of this separation is influenced by factors such as flow rate, the nature of the absorbent, the surface area exposed to the carrier gas and the column temperature. As the individual chemical components emerge from the column, the detector obtains a signal and relays the message to the data acquisition system.

As far as the advantages of micro GC go, they are much lighter and therefore portable, use significantly less carrier gas, have much faster analysis times, require far less power consumption, and are simpler and cheaper to operate and maintain. The models currently available also offer useful accessories such as a sample conditioner, gas stream switch valves, a transporting case, rechargeable battery packs and membrane filters.

Still, there are major drawbacks in using micro GC: the injector can only handle samples in the gaseous state, they cannot handle analysis of heavier carbon samples, they operate mostly isothermally with little to no temperature programming ability, and they employ a thermal conductivity detector that lacks sub-ppm sensitivity and is prone to masking analyte components eluting close to the matrix.

Agilent Technologies is the clear market leader with its 490 Micro GC series. A mobile version comes with a field case designed for out-of-lab use and can be controlled with a phone or tablet. For process analysis, Agilent also offers the 490-PRO, which features unattended operation, and on-board data handling and result calculations. These models can be configured with up to four different columns that can run in parallel with their own unique settings. INFICON is the second largest supplier. It offers the Micro GC Fusion, known for its fast analysis and Wi-Fi capabilities.

The market for micro or portable GCs was over $40 million in 2016. Sales have been detrimentally affected in recent years by a weak oil and gas industry, only slightly offset by demand from environmental labs. With the recent uptick in demand from oil refining and the current release of pent-up demand from oil & gas exploration, however, the market for these compact analyzers is expected to grow moderately over the next couple years.

Micro GC at a Glance:

Leading Vendors:

- Agilent Technologies
- INFICON
- Falcon Analytical

Largest Markets:

- Oil and Gas Exploration
- Refining and Natural Gas Processing
- Environmental

Instrument Cost:

- $12,000–$50,000

R&D

Earlier this month, the Organization for Economic Cooperation and Development (OECD) released its annual "Science, Technology and Industry (STI) Scoreboard" report, detailing the effects of digital technologies on innovation and the economy through a set of STI indicators.

Business R&D accounted for over 60% of R&D expenditures in the OECD between 2005 and 2015, staying stable during the decade, save increases in shares for China and Turkey, and decreases for Mexico, the Russian Federation and South Africa. Small- and medium-sized enterprises averaged 35% of business R&D in 2015.

The US had the greatest number of top-cited publications in 2015 at almost 500,000, followed by China with 398,000, approximately as many publications as the UK and Germany combined. International collaboration increased in 2015 in 32 out of 35 OECD member countries, with Luxembourg, Iceland, Switzerland and Belgium indicating the highest inclination to participate in collaborative projects.

Foreign sources of funding for R&D contributed significant amounts to business R&D in many OECD countries, such as Austria, Iceland, Ireland and Latvia. The UK received 8%, the greatest amount of EU funding, for R&D in higher education from the EU in 2014, and 50% of its business R&D was sourced from foreign-controlled affiliate companies.

Source: *OECD*

Biotechnology

The USDA has rescinded a regulatory strategy for biotech products that would have officially exempted certain modern gene-edited plants from being regulated. The proposed plan was withdrawn due to concerns from groups in industry and academia that the strategy would have increased the number of burdensome requirements for safety assessments in the early development stage of biotech products. In its announcement of the plan's withdrawal, the USDA stated that it is reexamining the rules to bolster public confidence and create a review process that will not interfere with biotechnological innovation.

The strategy was proposed in January and was meant in part to clarify where the Agency stands in regards to the regulation of plants made through new genetic technologies, such as CRISPR. Certain gene-edited plants would have been exempt from the definition of gene editing. The regulation would have required the USDA's Animal and Plant Health Inspection Service to begin evaluating plants for their potential of transforming into toxic weeds that are a danger to crops, animals, agriculture, the environment or human health. Risk assessment requirements would have also increased, with small companies and academics being affected the most due to the high costs associated with meeting the conditions. The USDA announced it will begin new discussions with stakeholders to explore alternative approaches.

Source: *Science*

Government

Expanding on a regenerative medicine framework first introduced in 2005, the US FDA launched a new policy initiative aimed at efficiently providing cell, stem cell and tissue products to patients. Earlier this month, the FDA released two draft guidance documents detailing the methods in which approvals for regenerative medicines can be accelerated for patients with serious diseases, and for using medical devices with regenerative medicines. Two final guidance documents were also released that clarified the cases in which cell- and tissue-based products would be

excluded from the regulations, as well as provided regulatory definitions of "homologous use" and "minimal manipulation." With these guidelines, the FDA aims to support innovation in drug development, and to protect patients from unsafe and unproven therapies.

In one of the draft guidelines, the FDA Center for Biologics Evaluation and Research (CBER) detailed the Regenerative Medicine Advanced Therapy (RMAT) designation that was established in the 21st Century Cures Act. The RMAT is used to hasten the review process for cell- and tissue- products. The CBER has received 34 requests for RMAT designation, of which it has acted on 31 requests and granted 11 RMAT designations. However, an RMAT designation does not guarantee that the product will be approved, nor does it exempt the manufacturer from demonstrating the product's efficacy and safety for approval. According to the draft guidance, the CBER plans to evaluate "the rigor of data collection; the nature and meaningfulness of the outcomes; the number of patients or subjects, and the number of sites, contributing to the data; and the severity, rarity, or prevalence of the condition" when it comes to determining products to be considered for RMAT designation.

Source: *Regulatory Affairs Professionals Society*

South Africa

According to the latest National Survey of Research and Experimental Development, South Africa's Gross Expenditure on R&D (GERD) in 2015–16 was ZAR 32.3 billion ($2.3 billion), a 10.2% jump. However, the rate of GERD growth declined 38.3% to 5.0%, due to limited R&D funding sources in government and the business sector. As a percentage of GDP, GERD in 2015–16 increased three basis points to 0.80%, a 1.3% rise.

All sectors increased expenditures on R&D, except the business sector. While business expenditures on R&D generally grew 3.9% to ZAR 13.8 million ($974 thousand) in 2015/16, in constant 2010 Rand values, R&D expenditures fell 1.0% to ZAR 10.4 million ($736.7 thousand). Approximately 20 State-Owned Enterprises (SOE) reported in-house R&D expenditures of ZAR 2.0 billion ($141 million), or 6% of GERD, which is a significant decline of 74.6% from peak SOE R&D expenditures in 2008–09, when SOE accounted for 16% of GERD.

Government expenditures on R&D increased 6.3% to ZAR 2.0 million ($141.9 thousand), while R&D spending in science councils and higher education jumped 14.7% and 17.9% to ZAR 5.7 million ($404.7 thousand) and ZAR 9.9 million ($696.3 thousand) respectively. The nonprofit sector's expenditures on R&D rose to ZAR 891.1 ($62.3 thousand), a 14.4% increase.

Source: *South African National Survey of Research and Experimental Development*

UK

On the heels of the UK government's announcement to increase national R&D spending 41.2% to 2.4% of national income by 2027, a new white paper on industrial strategy was released this week. The white paper highlights five areas in which the country will invest to improve economic performance and increase productivity.

According to the white paper, the government will establish an independent watchdog for the purposes of monitoring progress and enhancements made in areas such as technological innovation, infrastructures and workplace training. The government also plans to create long-term strategic goals in construction, life science, automotive and artificial intelligence, four key areas seen as having major potential for growth. A planned recent investment in the UK by Merck will create 950 jobs in the country, and can be used as an example of the type of societal and economic benefits that come with collaborations between the private, government and higher education sectors that the government wishes to encourage in the four key growth areas. The life science sector in the UK is one of the most rapidly developing industries, as it employs 233,000 across the country and has turnover of over £64 billion ($4.5 billion).

Trends affecting the achievement of the goals cited in the white paper include artificial intelligence, clean growth,

an ageing society and the impacts of future mobility (such as driverless cars and drones).

Source: *The Guardian*

Turkey

In 2016, gross domestic expenditures on R&D in Turkey jumped 19.5% to TRY 24.6 billion ($6.3 billion). Total R&D expenditures continued to steadily rise from 2010, increasing 6.8% in 2016 to represent 0.94% of the country's GDP.

The vast majority of R&D spending came from the financial and non-financial sector, which accounted for 54% of total expenditures, while the higher education sector made up 36%. The general government sector represented the remaining 10% of R&D expenditures. By type of cost, 50% of R&D expenditures went towards labor costs, while 39% and 11% of R&D expenditures were for other current costs and capital expenditures, respectively.

The financial and non-financial sectors financed 47% of total R&D expenditures in 2016, followed by the general government, which financed 35%. Higher education and foreign funds financed 14% and 4% of total R&D expenditures, respectively, while other national sources served as financiers for 0.1% of 2016 R&D spending.

The number of full-time R&D personnel increased 12% in 2016, totaling 136,953 employees. Of this, 53% were employed in the financial and non-financial sectors and 38% worked in higher education, while 9% of personnel were from the general government and the private nonprofit sectors.

Source: *Turkish Statistical Institute*

MS & LC/MS

Company Announcements

SpectralWorks and **MestreLab Research** announced in August a mutual reseller agreement for integration of MS and NMR sample submission, tracking and data processing.

In September, **SCIEX** named Inese Lowenstein as president, replacing Jean-Paul Mangeolle, who retired. Her most recent role was senior vice president, Global Sales and Service. Joe Fox, vice president of Separations, has taken over that position.

In November, **SCIEX Diagnostics** announced a joint venture with **Zhejiang Dian Diagnostics**, which researches, develops and supplies medical diagnostics products and services in China. The parties plan to establish a joint venture in Hangzhou, China, to develop, register, manufacture and commercialize Class I, II and III IVD reagents for the SCIEX Triple Quad 4500MD LC-MS/MS system, a solution approved by the **China Food and Drug Administration** earlier this year.

SCIEX and the **Protein and Proteomics Centre** under the **Department of Biological Sciences at the National University of Singapore's (NUS) Faculty of Science** announced the launch of a first-of-its-kind proteomics and MS training center in Southeast Asia in 2018 aimed at training the next generation of scientists to advance biomedical research and proteomics studies across Asia Pacific. The NUS and SCIEX have collaborated before.

Cayman Chemical announced in September a collaboration with **Thermo Fisher Scientific** and **HighChem** to provide tandem spectra to the mzCloud library of mass data.

In September, **Biognosys** entered into a co-marketing agreement with **Waters** to provide a workflow for Data-Independent Acquisition (DIA) MS-based proteomics studies by combining their respective Spectronaut Pulsar software and SONAR data acquisition technology.

Agena Bioscience entered into a strategic partnership in September with **Molecular Health** (MH), a provider of cloud-based decision support technology for precision medicine. MH's Molecular Health Guide analysis platform will aid interpretation of raw data generated by Agena's MassARRAY System. The relationship is part of Agena's MassARRAY Insights reporting network.

In October, **Agena Bioscience** announced a strategic partnership with **N-of-One** to provide interpretation of cancer genomic data generated by its MassARRAY system. This relationship is also part of Agena's MassARRAY Insights reporting network.

LabCyte in September announced **GSK** and **AstraZeneca** as members of a consortium to combine acoustic liquid dispensing technology MS for high-throughput small molecule screening and other drug discovery applications. LabCyte plans to launch a commercial Acoustic-MS system designed to support a broad range of assays.

In September, **Microsaic Systems** named COO Glenn Tracey as CEO.

Protea Biosciences announced in October that it plans to develop clinical screening assays in various areas of oncology. The assay will be developed on **Bruker**'s rapifleX MALDI Tissuetyper.

In its third quarter conference call, **PerkinElmer** announced the registration of its QSight MS system as a Class I device with the US **FDA** and the completion of CE marking in Europe. The CE marking enables use in clinical applications beyond newborn screening.

In October, **Hiden Analytical** signed an agreement with the **University of California, Berkeley Laboratory** to produce a novel dual-layer differential electrochemical flow cell for operating with its HPR-40 DSA membrane inlet MS.

Astrotech, whose **1ˢᵗ Detect** business manufactures MS-based system for chemical analysis, announced in November the expansion of its review of strategic alternatives to include those involving the company as a whole as well as the subsidiaries.

In November, **Shimadzu Scientific Instruments** announced a collaborative relationship with **Northern Michigan University** (NMU) to support NMU's new four-year undergraduate degree program in Medicinal Plant Chemistry. The support includes a grant to purchase a triple quadrupole LC/MS system.

Product Introductions

In September, **Hiden Analytical** launched the Hiden CATLAB-PCS combined microreactor and MS system for the characterization and evaluation of catalysts for temperature-programmed desorption and reaction testing, and for general thermal studies.

PerkinElmer introduced in September the QSight 210 MD System, a tandem MS system for neonatal screening applications designed to run hundreds of samples per day. It features a complete workflow, including sample preparation.

In September, **SCIEX** released the CE-marked SCIEX Topaz LC-MS/MS System for clinical diagnostics in Europe.

Shimadzu debuted in September the DPiMS-2020 probe electrospray ionization MS, which uses Probe Electro Spray Ionization (PESI) for sample ionization without pretreatment. It requires only adding 10 pL or less of liquid from a chemical product, food ingredient or biological sample on a plate for complete preparation.

In November, **Biognosys** released a new version of QuiC, an easy-to-use tool to monitor performance of a proteomics workflow over time. QuiC automatically analyzes MRM (Multiple Reaction Monitoring), PRM (Parallel Reaction Monitoring), DDA (Data Dependent Acquistiion) and DIA (Data Independent Acquisition) data, and extracts LC and MS performance indicators.

Shimadzu launched in November the MALDI-8020 MS, stating it offers the world's highest level of analytical performance in a benchtop model. The system is half the size of existing Shimadzu MALDI systems.

Sequencing

Company Announcements

In September, **Illumina** announced an agreement with **Advanced Analytical Technologies** to support collaborations and comarketing activities.

1CellBiO signed in September a reseller and license agreement with **Hangzhou Chengyuan Genomics** for its inDrop instrument for single-cell RNA sequencing.

In October, **Pacific Biosciences** integrated its de novo assembly pipeline onto **Bluebee**'s genomics analysis platform.

10x Genomics announced in October a partnership agreement with the **Human Cell Atlas** international consortium to help enable pilot projects. Consortium collaboration members will be able to purchase the 10x Chromium Single Cell 3' and 5' RNA Analysis Solutions at discounted prices. The company will also provide technical solutions.

Thermo Fisher Scientific announced in October that its Oncomine Dx Target Test, an NGS-based companion diagnostic for non-small cell lung cancer, received a positive coverage decision by **Regence Blue Cross/Blue Shield**. This makes it available to members in four states.

In October, **Fabric Genomics** announced partnerships with **Genomics England**, **Rady Children's Institute for Genomic Medicine** and the **Utah Genome Project** to provide identification of pediatric disease causing variants to improve the clinical care of children using its Opal Clinical platform.

Edico Genome and **Fabric Genomics** announced in October a collaboration to provide an integrated solution for secondary and tertiary analysis of NGS data by utilizing Edico's DRAGEN Bio-IT platform with Fabric Genomics' Opal Clinical variant interpretation platform.

Edico Genomics announced in November an affiliation with **Children's Hospital Los Angeles**. The Hospital has validated DRAGEN's Germline V1 pipeline, and will begin utilizing the pipeline for clinical exome sequencing tests for patients in urgent need for diagnosis.

Pacific Biosciences named Kathy Ordoñez as COO and executive vice president in October.

ReadCoor, developer of Fluorescence *in situ* Sequencing (FISSEQ) spatial sequencing technology, announced in November a collaboration with the **Joint Pathology Center**, a pathology reference center for the US government.

In its third quarter results **SEC** filing, **Bio-Rad Laboratories** disclosed that it has shut down its **GnuBIO** operation (see ***IBO*** 4/15/14).

Genialis, a provider of cloud software for the visual exploration of NGS data, closed a $2.3 million seed round in November. The round was co-led by **Redalpine Venture Capital** and **First Star Venture Capital**.

In November, **Global Gene**, a genomics data platform and applications firm, announced a collaboration with the **Ohio State University Comprehensive Cancer Center–Arthur G. James Cancer Hospital** and the **Richard J. Solove Research Institute, Department of Radiation**, to develop a better understanding of rare cancers in South Asian and Indian populations.

LGC Genomics signed a distribution agreement with **Diagenode** in November for Diagenode's sonication systems for DNA fragmentation. The agreement covers EMEA, South America and Canada for clinical and agricultural biotech market segments and the US for the agricultural biotech sector.

In November, **Base4 Innovation** announced the closing of an oversubscribed funding round, capped at £5 million ($7 million), led by **Longwall Ventures**. Base4 is developing a microdroplet-based sequencing method that generates long reads from a single molecule of DNA without the need for initial amplification. The company

currently has 32 employees.

Microbe firm **Biomillenia** announced in November a collaboration with QIAGEN for use of QIAGEN's Microbial Genomics Pro Suite to generate NGS data on microbes.

Partek and **Lexogen** announced in November a collaboration resulting in a new analysis pipeline based on their respective Partek-Flow software and QuantSeq 3' Library Prep Kits.

In November, **LGC** and **NuGEN** entered into a collaboration agreement for the commercialization of the NuGEN's Single Primer Target Enrichment Technology (SPET) and distribution of NuGEN's Allegro Targeted Genotyping reagents for NGS library preparation. The technology is well suited to address large-scale genotyping in agrigenomics. The agreement supports LGC's SPET-based SeqSNP services.

Product Introductions

In September, **Lexogen** launched the SLAMseq product family for high-throughput metabolic sequencing of RNA, developed in collaboration with Austria's **Institute of Molecular Biotechnology**. SLAMseq can differentiate between nascent RNA and existing RNA versus standard RNA-Seq, which measure total steady-state RNA levels only. Sampling at different time points reveals the complete in vivo and transcriptome-wide kinetics of RNA synthesis and degradation.

Phase Genomics introduced the ProxiMeta Hi-C metagenome deconvolution product, featuring what it calls the first commercially available Hi-C kit. Using an enhanced version of the chromatic capture technique Hi-C, it measures the physical structure of microbial genomes while their cells are still intact.

iGenomX released in October Riptide High-Throughput Rapid Library Prep (HT-RLP), enabling users to create up to 960 high-quality NGS libraries using a low-cost, scalable solution. It is intended for use on small genomes and synthetic DNA constructs.

In October, **Swift Biosciences** unveiled the Accel-Amplicon Custom NGS Panels to enable clinical researchers to rapidly design highly focused panels to discover, validate and screen disease genes and their variants. It requires only 10 ng of sample input, features an under two-hour library prep workflow, and supports either the **Ion Torrent** or **Illumina** platform. By partnering with **Genialis**, Swift integrates alignment, trimming, QC and variant calling into one pipeline.

In November, **Dolomite Bio** launched the open, scalable Nadia single-cell platform, a touchscreen-controlled, droplet-based microfluidic platform for single-cell research. One, 2, 4 or 8 samples can be run in parallel, generating up to six thousand high-quality single-cell libraries per sample in approximately 15 minutes.

In October, **Illumina** debuted the NovaSeq S4 flow cell, reagent kit and NovaSeq Xp workflow for its NovaSeq 6000 System. The flow cell delivers up to 6 TB of output in two days, with users sequencing up to 48 human genomes or 384 exomes per run in less than 40 hours. The NovaSeq Xp enables users to load libraries directly into the individual lanes of the flow cells.

Illumina introduced in November the NextSeq 550Dx, its second FDA-regulated CE-IVD marked platform for the clinical lab. It includes diagnostic and research modes. The setup for different applications are fully integrated in the system's software. The company also provided an updated intended use for its MiSeq Dx instrument to include the use of DNA libraries generated from FFPE tissues. For the MiSeq Dx, Illumina launched the regulated MiSeqDx Reagent Kit v3 and the TruSeq Custom Amplicon Kit Dx.

Pillar Biosciences, a clinical cancer diagnostics company, announced in October a collaboration with **Illumina** on NGS-based IVD tests. Pillar will lead development of tests to run on Illumina's MiSeq Dx instrument.

10x Genomics introduced in October more affordable pricing for its Chromium Genome, Exome and de novo Assembly Solutions. The new list price of $200 per sample for the high-throughput kit configuration is available in the US and Canada.

10x announced in October the launch of the B-Cell and 5'Unbiased Enrichment Kits for its Chromium Immune

Repertoire Profiling Solution, which utilizes massively parallel single-cell RNA-seq to sequence paired V(D)J B-cell receptors, together with unbiased gene expression for reading the immune-repertoire along with cell phenotype. The full combination of features within the updated Single Cell V(D)J Solution enables a single sample to be analyzed simultaneously for cellular heterogeneity, phenotype, T-cell receptor repertoire and B-cell immunoglobin repertoire.

In October, **Oxford Nanopore** announced it is developing target enrichment processes for its nanopore sequencing platform based on the CRISPR/Cas9 system.

Oxford Nanopore announced in November the early release of a new version of its rapid sequencing kit that does not require refrigeration during transit or on site.

In October, the **International Commission on Missing Persons** (ICMP) and **QIAGEN** debuted an NGS workflow for ICMP's missing-persons DNA identification lab in the Hague. The parties worked together to create an SNP panel specifically designed for missing persons' identification, targeting more than 1,400 sites in the human genome.

In October, **MGI Tech**, a subsidiary of **BGI**, launched the MGISEQ-2000 and MGISEQ-200 sequencers, and the modular MGIFLP NGS workstation. The systems are upgrades to BGI's BGISEQ 50/500 platforms. They can complete one run with PE100 read length in less than 48 hours, and can run with at least 4 different read lengths. MGI plans to release sequencing adapters and the test data to encourage users to develop their own applications on the MGISEQ platform. Shipments will be in February 2018, initially in China.

In November, **Invivoscribe Technologies** released the RUO version of its LymphoTrack *TRB* Assay for the **Illumina** MiSeq platform. The test identifies clinical TRB (VDJ) rearrangements and the associated VDJ region DNA sequences, as well as provides the frequency of distribution of V, D and J, and region segmentation utilizing using the LymphoTrack bioinformatics software.

New England Biolabs introduced in November the NEBNext Ultra II FS DNA Library Prep Kit, which employs a novel enzymatic fragmentation system that combines fragmentation, end repair and dA-tailing in a single tube, and utilizes a single protocol regardless of input amount or GC content.

SeraCare Life Sciences introduced the Seraseq Myeloid DNA and Myeloid RNA fusion reference materials, calling it the first comprehensive reference standards for NGS-based assays focused on myeloid cancers.

In November, **BioDiscovery** launched the NxClinical 4.0 system for analysis and interpretation of CNV, SNV and AOH (Absence of Heterozygosity) from a single NGS assay. It brings together cytogenetics and molecular genetics. All genomic variations are incorporated into a single database system.

Covaris unveiled in November the 96 oneTUBE-10 AFA Plate, which enables scalable and simplified workflows by leveraging Covaris' focused-acoustic technology. The new product eliminates transfer steps.

In November, **Edico Genomics** released the comprehensive DRAGEN Clinical Genomics Information System, designed to enable clinical labs of all sizes to quickly, simply and efficiently develop sequencing based LDTs.

In November, **Roche** launched the HyperCap Target Enrichment Portfolio, a streamlined and fully integrated NGS sample preparation solution. It integrates the KAPA DNA Library Prep with SeqCap EZ target enrichment portfolio, and is a further expansion of the HyperCap v1.0 workflow. The company also introduced Universal Blocking Oligos, which enhance the performance of capture experiments through the prevention of cross-hybridization between adapter sequences.

Sales/Orders of Note

In October, **BC Platforms** announced that **Biogen** and the **Accelerated Cure Project** will use its BCRQUEST.COM platform to better understand the genetic basis of multiple sclerosis. **Microsoft** will provide the cloud platform.

WuXi NextCODE announced in October the first open access installation of **Oxford Nanopore** instruments in a CAP/CLIA lab in China at its lab in Shanghai.

Genomics England announced in October a partnership with **Inivata** and **Thermo Fisher Scientific**. The pilot project aims to assess the quality of blood plasma samples and explore the potential liquid biopsy testing to improve disease management and patient outcomes.

Cancer sequencing service provider **Intermountain Precision Genomics** announced in October the addition of **10x Genomics'** Chromium Genome Solution to its Translational Science Center.

Cancer Genetics, a lab services provide for genomic and biomarker information, announced in November that it is offering **Thermo Fisher Scientific**'s Oncomine Dx Target Test to physicians.

In November, the **NIH** selected **Seven Bridges** to support the NIH Data Commons Pilot Phase. The company will lead a team consisting of **Repositive**, **Elsevier** and the **Boston Veterans Affairs Research Institute**.

GC & GC/MS

Company Announcements

ALPHA MOS announced in June, according to Reuters and a document translated by Google Translate, the sale of 50% of the company's voting rights held by **Diagnostic Medical Systems** to **Jolt Capital** and **Ambrosia Investment**s for €6.5 million ($7.3 million). Jolt and Ambrosia are to launch a tender offer for the remaining shares of the company.

In October, **INFICON** announced that its third quarter Security & Energy sales declined 46.9% to $5.1 million.

In November, **Agilent Technologies** recognized **Dow Chemical**'s Gas Chromatography Centre of Expertise at Alberta Operations for outstanding collaboration in developing the Agilent Intuvo 9000 GC and Agilent 8355 Sulfur Chemiluminescence Detector. The companies' collaboration spans 28 years.

Product Introductions

In August, **LECO** introduced the Pegasus GC-HRT$^+$ and GC-HRT$^+$ 4D GC and GCxGC-TOF MS systems. New to the systems is the Encoded Frequent Pushing method for increased duty cycle.

In September, **Teledyne Tekmar** launched the Atomx XYZ Automated Purge and Trap concentrator with integrated autosampler for automated analysis of volatile organic compounds in soil and water samples. It features a reduced footprint compared to earlier Atomx systems and increased vial capacity, as well as redesigned software.

For its GC/MS systems, **Shimadzu** released in October the Polymer Additives Library, which contains 4,869 mass spectra of 494 types of polymer material additives.

In November, **Shimadzu** debuted the TD-30 series thermal desorption systems for analysis of volatile compounds: the mid-range TD-30, which can process up to 60 samples, and the high-end TD-30R, which can process up to 120 samples. They feature the ability to accommodate a wide range of components.

In October, **Thermo Fisher Scientific** announced an update to its Thermo Scientific Orbitrap GC-MS systems, adding Variable electron Voltage (VeV) technology, the Orbitrap GC-MS HRAM Metabolomics Library and new TraceFinder Automated compound Identification software.

Phenomenex, a **Danaher** company, unveiled in October the Zebron ZB-PAH GC columns for PAH analysis features faster analysis times and greater resolution.

Atomic Spectroscopy

Company Announcements

In October, **Olympus NDT (NonDestructive Testing) Canada** officially inaugurated a new CAD 37 million ($30 million), 15,794 ft^2 (15,794 m^2) office and manufacturing complex in the Michelet Innovation Zone in Quebec. The business intends to increase the number of employees from 380 to over 400.

ZEISS Microscopy signed in October an exclusive strategic partnership agreement with **Xnovo Technology**, a developer of software-based 3D x-ray imaging and analysis solutions. The companies have worked together for two years. The partnership seeks to expand the lab-based diffraction contrast tomography technique commercialized as LabDCT on the ZEISS Xradia 520 Versa. The module nondestructively obtains 3D crystallographic information from polycrystalline samples.

In October, **TSI** entered into a distribution agreement with **Arconic**, a manufacturer of spectrochemical reference materials for aluminum alloys. TSI will resell Arconic's MicrO Reference Materials in a convenient, easy-to-use kit for field standardization of its ChemLite LIBS metal analyzers.

In November, **Rigaku Europe** opened a new headquarters in Neu-Isenburg, Germany. The new office is home to an application development and demonstration facility.

Analytik Jena announced in November a cooperation agreement with the **Federal Institute for Materials Research and Testing (BAM)** for the R&D of optical spectrometry in the area of elemental analysis, including high-resolution absorption spectrometry for ultra-trace analysis; specifically, the company's High-Resolution Continuum Source atomic absorption system.

Product Introductions

In September, **Olympus** introduced the Vanta L Series of handheld XRF analyzers, which can be calibrated for alloy, precious metal and geochem applications. Features include the ability to withstand a temperature range of -10–50 °C, and optional Wi-Fi and cloud connectivity.

Olympus launched in October the new Vanta VCA handheld XRF analyzer for measurement of a wide range of elements. It features a three-year warranty and an intuitive interface.

Thermo Fisher Scientific released in October an update to its Thermo Scientific Niton XL5 handheld XRF analyzer, including the introduction of mining and soil modes. New accessories include the mini test stand for improved portability.

In October, **Rigaku Oxford Diffraction** debuted the high-flux XtaLAB Synergy-DW dual-wavelength single-crystal diffractometer. It features a hybrid photon counting detector and four-circle kappa goniometer.

In November, **Rigaku Analytical Devices** introduced an upgraded version of its KT Series LIBS metal analyzer, expanding the use of handheld LIBS for use in more applications. It produces higher throughput and better resolution.

Spectro Scientific released an upgrade to its FieldLab 58 consisting of a more powerful XRF module and newly designed filter that improves the limits of detection for wear metal elements in oil. XRF is one of four analytical technologies utilized by the system.

Sales/Orders of Note

In September, **SPECTRO Analytical Instruments**, a unit of the Materials Analysis Division of **AMETEK**, announced the delivery of its 10,000th SPECTROMAXx metal analyzer to **Geely Automobile**, a Chinese automotive and motorcycle manufacturer.

Reported Financial Results

$ in Millions USD	Period	Ended	Sales	Chg.	Op. Prof.	Chg.	Net Prof.	Chg.
Agilent Technologies	Q4	30-Sep	$1,189.0	7.0%	$233.0	27.3%	$177.0	40.5%
Agilent Tech. (Life Sci. & App.)	Q4	30-Sep	$575.0	4.9%	$138.0	10.4%	NA	NA
Agilent Tech. (Diag. & Genom.)	Q4	30-Sep	$210.0	8.8%	$44.0	15.8%	NA	NA
Agilent Tech. (Crosslab)	Q4	30-Sep	$404.0	9.2%	$92.0	9.5%	NA	NA
Agilent Technologies	FYE	30-Sep	$4,472.0	6.4%	$841.0	36.7%	$684.0	48.1%
Agilent Tech. (Life Sci. & App.)	FYE	30-Sep	$2,169.0	4.6%	$487.0	13.5%	NA	NA
Agilent Tech. (Diag. & Genom.)	FYE	30-Sep	$772.0	8.9%	$149.0	30.7%	NA	NA
Agilent Tech. (Crosslab)	FYE	30-Sep	$1,531.0	7.8%	$338.0	7.0%	NA	NA
Brooks Automation (Life Science)	FYE	30-Sep	$148.7	37.6%	$4.7	-172.8%	NA	NA
Datacolor	FYE	30-Sep	$72.8	5.1%	$6.4	3.2%	$6.8	13.3%
Meridian Bioscience (Life Science)	Q4	30-Sep	$13.7	13.6%	$2.9	49.7%	NA	NA
Meridian Bioscience (Life Science)	FYE	30-Sep	$57.3	12.3%	$14.1	8.4%	NA	NA
MTS Systems (Test)	Q4	30-Sep	$124.8	-14.6%	$1.8	-89.8%	NA	NA
MTS Systems (Test)	FYE	30-Sep	$512.3	10.7%	$40.7	-3.8%	NA	NA
Repligen	Q3	30-Sep	$36.5	48.0%	($0.4)	-110.8%	$4.7	304.2%
VWR	Q3	30-Sep	$1,195.2	5.2%	$83.1	-0.1%	$49.1	20.9%
Other Currencies (in Millions)								
Halma (Environmental Analysis)	H1	30-Sep	£117.0	17.9%	£22.0	35.8%	NA	NA

N/A = not available, NM = not meaningful
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