IBO
Strategic Information for the Life Science and Analytical Instrument Industry

a publication of Strategic Directions International

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

Volume 27, Issue 16
November 30, 2018

NSF Establishes Mid-scale Research Infrastructure Opportunities

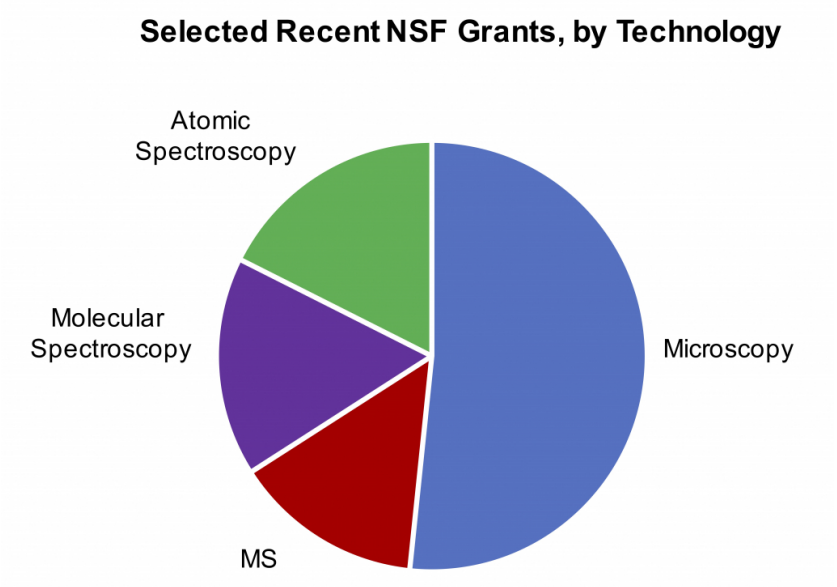
The NSF has long supported scientific research instrumentation purchases through funding mechanisms such as the Major Research Instrumentation (MRI) program and the Major Research Equipment and Facilities Construction (MREFC) account, making investing in research infrastructure a key priority over the past 60 years. From macro-based research projects, such as ecosystems and earth studies, to micro-based projects, such as cell and gene studies, the MRI and MREFC programs have fostered infrastructure and instrumentation purchases to enable

analytical instrument purchases and infrastructure.

However, the majority of NSF awards that are in the $20–$70 million range are mostly allocated to centers, institutes, and large facility operations and maintenance, with little investments made in mid-scale research and cyber infrastructure. Moreover, the NSF has found that despite the lack of funding for mid-scale projects, there are opportunities for these projects and an extremely strong interest in mid-scale infrastructure across virtually all disciplines. To address this discrepancy, the NSF last month announced that it will begin to provide awards for mid-scale research projects that will include funding for "the creation of mid-scale disciplinary instrumentation to the implementation (including acquisition and construction) of mid-scale facilities." These opportunities will not only help broaden the scope of scientific research funding, but also potentially result in more instrumentation purchases, infrastructure contracts and international collaborations.

Recent MRI Awards

A dataset summarizing recent NSF MRI awards indicates that the vast majority of awards were granted for the purpose of purchasing or developing surface science instruments. TEM, SEM, AFM, laser scanning confocal and fluorescence microscopes were among the instruments frequently cited by scientists as being imperative to their research, which largely revolved around cells and proteins, as well as genomics and materials characterization.



Selected MRI grants, October 2010 – November 2018

This overwhelming majority of microscopy purchases by researchers can be attributed to advancements in the speed of detectors that are sensitive to electrons, according to a recent *Nature* article. Although TEMs have remained generally the same since their development almost 90 years ago, their resolution power has improved by a factor of over one thousand. By the late 2000s, electromagnets were able to correct electron beam distortions reaching sub-angstrom resolution. Additionally, biologists are now able to utilize extremely sensitive "direct-electron detectors," which became easily accessible in the early years of this decade, and led to the development of the cryo-EM technique, which has advanced biomolecule structure research.

Many recent MRI awards were also used to purchase atomic spectroscopy instruments, such as crystal, powder, microfocus and dual-source XRDs, as well as ICP, IC-ICP-MS and ICP-MS systems, including those that have laser ablation or LC capabilities. Several researchers also utilized awards to purchase TOF systems, including TOF-SIMS, TOF-ICP-MS and MALDI-TOF-TOF platforms. Molecular spectroscopy was also a popular technology, specifically

NMRs, with numerous researchers purchasing new NMRs or upgrading NMR consoles.

Restructuring Funding Opportunities

The NSF has supported scientific research through mechanisms such as its MRI program and MREFC program that provide funding for infrastructure and instrumentation. According to the NSF in a recent report, research infrastructure is defined as "any combination of facilities, equipment, instrumentation, computational hardware and software, and the human capital needed for associated support." However, over the past few years, the research community has discussed the need for a mid-scale mechanism to better enable scientific research that does not require the time and resources of the larger research projects that are funded by the MREFC.

"Mid-scale" is described as pertaining to projects that are between the current maximum limit of the MRI program, which is $6 million or $9 million, and the current minimum limit of MREFC eligibility, which is $70 million. Advances in technology have steadily created larger gaps in the amount of funding specific projects need, according to the report. In its study of mid-scale projects, the NSF found that many awards are less than $5 million, but projects requiring funding between $10 million and $70 million are predicted to increase as the use of big data and AI continue to rise. Moreover, the cost of certain instruments exceed the upper limit of the MRI program, and researchers are more frequently requiring networks of instruments.

In its report, mid-scale research infrastructure (Mid-scale RI) is described by the NSF as being critical to many areas of scientific research. Mid-scale RI includes instruments and suites of instruments, according to the NSF's report, both "off-the-shelf" instrumentation as well as cutting edge custom tools. The NSF separates Mid-scale RI into three categories: cyberinfrastructure, investments to enhance or upgrade existing NSF large research centers and discrete Mid-scale RI, which is defined as "instrument/suites of instruments and multi-user facilities that are mid-scale in size and exist apart from large facilities."

The report states that investments in Mid-scale RI, instrumentation and state-of-the-art multiuser facilities made by other countries are attracting US researchers to work abroad. Therefore, in order for the US to continue to be competitive internationally, it is imperative to establish a Mid-scale RI mechanism to support scientists that require research infrastructure that exceeds the MRI maximum funding level, but falls below the current funding levels provided by the MREFC. The NSF report determined that the figures required to support internationally competitive mid-scale research are between $60 and $100 million per year for Mid-scale RI, and between $20 million and $70 million for cyberinfrastructure programs. The exact investment amounts may be adjusted in accordance to enacted NSF budgets.

One possible source of funding the NSF cited for the Mid-scale RI mechanism is the MREFC account. The report argues that using the MREFC will complement the National Science Board's (NSB) notion of having a centrally managed account to streamline the NSF's strategic planning and portfolio management. However, the NSF would have to make statutory changes to enable the MREFC to fund the Mid-scale RI program, such as a tiered risk-appropriate oversight model. The management structure of the NSF and the NSB's oversight structures would also require modifications, according to the report's recommendations, and both the NSF and NSB would benefit from developing a program that evaluates and assesses the actual scope of demand for Mid-scale RI to guarantee that the NSF's programs meet those requirements.

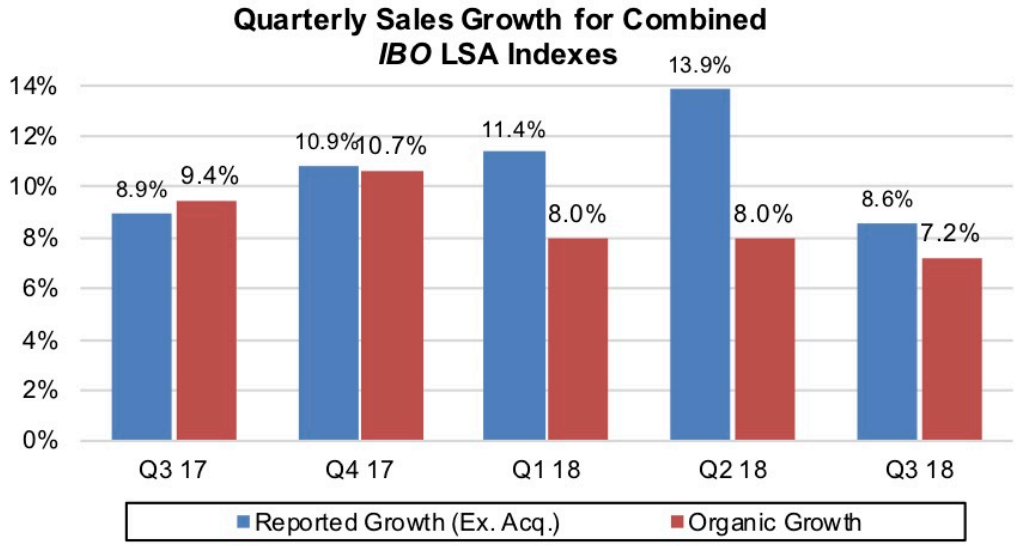
IBO Sales Indexes: Life Science Index Leads Growth

Publicly held analytical instrument and lab product businesses continue to post healthy sales growth in the last quarter, continuing their 2018 streak. Calendar year third quarter for the 20 business units tracked by ***IBO***'s Life Science and Analytical Sales Indexes posted a combined increase in organic sales of 7.2%.

Of the 20 companies that make up the Indexes, 7 businesses achieved double-digit growth: Agilent Technologies Crosslab, Bio-Techne Protein Sciences, Fluidigm, Illumina, HORIBA Process and Environmental Instruments & Systems and Scientific Instruments & Systems each; Oxford Instruments and Thermo Fisher Scientific Analytical Technologies. Acquisitions had a minimal effect on each of these businesses' growth rate.

Growth was led by Illumina (see ***IBO*** 11/15/18) and Bio-Techne Protein Sciences (see Third Quarter Results: Agilent Technologies, Bio-Rad Laboratories, Bio-Techne, Bruker, Merck KGaA, QIAGEN and Shimadzu). Four companies, Bruker, Merck Life Science, PerkinElmer and Thermo Fisher, raised fiscal year guidance, while one company, Waters, lowered it. Agilent ended its fiscal year this quarter, reporting 7.1% core growth for the year, up from 6.7% in the prior fiscal year.

Companies once again reported momentum for the biopharmaceutical end-market, China, and consumables and service sales. Most businesses reported minimal effects of the US-China's trade war. However, Illumina did note that for a second quarter consumables stocking by Chinese customers in case of tariffs increased its consumables revenue growth.



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End-markets

Pharmaceutical sales were robust for many companies, including Thermo Fisher, which reported high teens growth. In contrast, Shimadzu Analytical & Measuring Instruments (AMI) and Waters reported restrained spending by its pharma customers, although Waters noted double-digit sales growth in China.

Similar, regional growth played a role in the growth of other end-markets. Agilent and Shimadzu AMI each highlighted environmental sales in China. Several businesses, including Thermo Fisher and Waters, noted positive developments in the US academic market. And globally, the academic market were good for many Index businesses, with both Agilent and Bio-Techne Protein Sciences recording double-digit sales growth.

Industrial markets, which include chemical and energy providers, were stable. Agilent and Thermo Fisher each reported strength among these customers. Activity in the food market appeared more mixed as PerkinElmer Discovery & Analytical Solutions reported double-digit growth but Agilent recorded flat sales, as changes at Chinese agencies once again affected its quarterly sales results for this sector. Both Bruker and Oxford Instruments noted strength for instrumentation for nano analysis applications.

Geographic Markets

Chinese sales fueled revenue increases for most businesses. Companies that reported double-digit revenue growth in the country included Agilent, Biotage, Bio-Techne, Illumina, Thermo Fisher and Waters. In contrast, Bruker noted weaker year-to-date growth and Waters cited slow sales for its TA unit. Nonetheless, companies in general were upbeat about the country's prospects across end-markets for the calendar year fourth quarter and 2019.

Excluding China, Asia Pacific sales also grew, with Illumina reporting its strongest sales growth in the region since early 2014. Merck Life Science (LS), Oxford Instruments and PerkinElmer also recorded double-digit revenue increases.

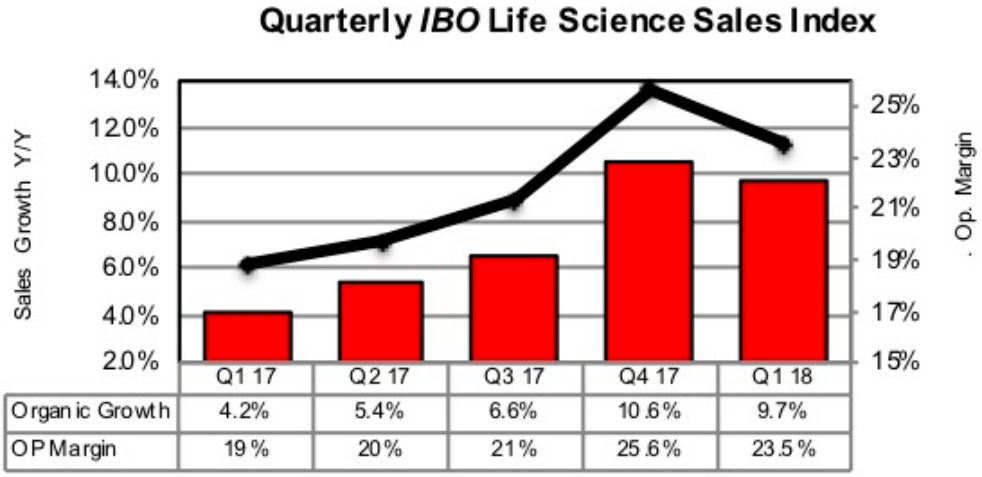
North American sales maintained their strength. Merck LS and Waters posted particularly strong growth in Latin America. In general, European sales growth trailed other major regions but still grew.

Product Lines

Sales of life science product lines, notably those for sequencing and cell biology, were robust in the calendar year third quarter. Agilent Technologies and Bio-Rad Life Sciences highlighted cell biology sales, while Illumina, QIAGEN and Thermo Fisher each reported strong clinical NGS sales. MS continued to deliver growth for Agilent and Bruker Scientific Instruments. Shimadzu AMI and PerkinElmer noted strength in sales of spectroscopy systems. Other standout product lines included Agilent's ICP-MS systems, Fluidigm's mass cytometry systems, Illumina microarrays and Thermo Fisher's electron microscopy business. Services sales were robust for Illumina and PerkinElmer.

Life Science Sales Index

Organic revenues of 10 businesses in the ***IBO*** *Life Science Sales Index* increased at a healthy pace in the calendar year third quarter, bolstered by especially strong results for Bio-Techne Protein Sciences, Merck LS and Illumina. Companies noted strength in both system and consumables sales, as well as healthy pharmaceutical and academic end-markets. The figures below include estimates for Tecan.



	Q1 17	Q2 17	Q3 17	Q4 17	Q1 18
Organic Growth	4.2%	5.4%	6.6%	10.6%	9.7%
OP Margin	19%	20%	21%	25.6%	23.5%

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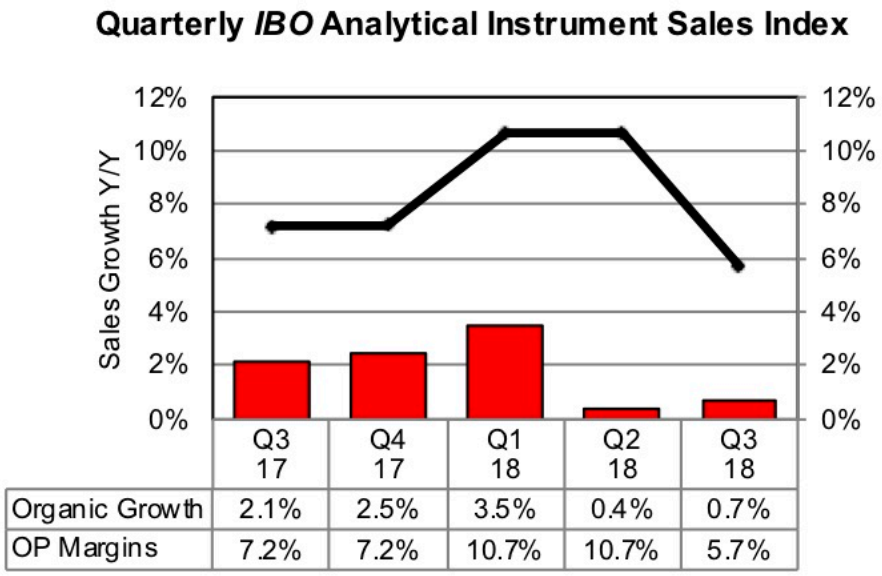
IBO *Life Science Index*: Bio-Rad Laboratories (Life Science); Biotage; Bio-Techne (Protein Sciences); Fluidigm; Illumina; Merck KGaA (Life Science); NanoString Technologies; Pacific Biosciences; QIAGEN (Life Sciences); Tecan (Life Sciences); Thermo Fisher Scientific (Life Science Solutions).

Analytical Sales Index

Sales for the businesses in ***IBO****'s Analytical Sales Index* were essentially flat, affected by currency effects primarily as well as Waters' slower sales growth. Several firms reported healthy growth driven by strength in specific product lines and by China. Operating profit growth slowed slightly as companies continued to invest for future growth. The figures below include estimates for Spectris.



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***IBO** Analytical Instrument Index*: Agilent Technologies (Life Sciences and Applied Markets, Agilent Crosslab); Bruker (Scientific Instruments); HORIBA (Process and Environmental Instruments & Systems, Scientific Instruments & Systems); Oxford Instruments; PerkinElmer (Discovery and Analytical Solutions); Shimadzu (Analytical and Measuring Instruments); Spectris (Materials Analysis); Thermo Fisher Scientific (Analytical Technologies); Waters.

LGC Adds to QC Standards

London, UK 11/26/18; Chicago, IL 11/26/18—Life sciences firm LGC has acquired SeraCare Life Sciences from Linden Capital Partners for an undisclosed amount. SeraCare Life Sciences provides QC materials for infectious disease testing and NGS. Product lines include bulk plasma, panels for developing diagnostic assays and clinical controls for instrument calibration. "The team will be a natural fit and addition to our existing calibration verification business, providing an expanded portfolio of quality control solutions to customers," stated Euan O'Sullivan, managing director, LGC's Standards division. "This significant acquisition will also strengthen our presence in the fast growing molecular diagnostics and NGS reference materials market, complementing our genomics offering." SeraCare, which has 170 employees, will continue to operate from its US facilities.

*This purchase expands LGC Standards' reference standards for a fast growing market, diversifying its life science offerings. Linden Capital acquired SeraCare in 2012 for $81 million, taking the company private (see **IBO** 5/31/12). PE Hub reports an approximately 4x return on the investment.*

AMETEK Buys Fuel Testing Company

Berwyn, PA 11/27/18; Chelmsford, MA 11/27/18—AMETEK, a manufacturer of electronic instruments and electromechanical devices, has acquired Spectro Scientific for $190 million. Spectro Scientific supplies solutions, including instrumentation and software, for the determination and monitoring of fluid conditions. The company generates annual revenues of $50 million. "[Spectro Scientific's] differentiated solutions serve an increasing need for predictive maintenance in a broad and growing set of end-markets, including military and defense, process, power generation and transportation," stated AMETEK Chairman and CEO David A. Zapico, "Spectro's solutions nicely complement our strategy to integrate instrumentation data with cloud-based software and analytics."

Spectro Scientific's product lines include online and lab analysis systems utilizing atomic or molecular spectroscopy techniques for the analysis of fluids, such as engine oil, lubricants and hydraulic fluids. The acquisition enhances AMETEK Electronic Instruments Group sizable presence in oil and fuel analysis. Spectro Scientific was sold by SFW Capital Partners, which acquired the firm in 2011 (see **IBO** *8/15/11).*

Tosoh Invests in Continuous Chromatography

King of Prussia, PA 11/29/18—LC provider Tosoh Bioscience announced that it plans to acquire Semba Biosciences following an equity investment in the company. Semba Biosciences develops and sells multicolumn continuous chromatography systems for the purification of biomolecules. "By combining Semba Biosciences' advanced Simulated Moving Bed (SMB) technology with Tosoh Bioscience's best-in-class resins, we will be able to offer the most productive and the most efficient solution in bioprocess chromatography while maintaining the highest quality," stated Ali Soleymannezhad, director of Sales and Marketing at Tosoh Bioscience. The companies have collaborated since 2007.

Tosoh Bioscience provides columns and resins that can be used with Semba Biosciences' SMB systems. This will be Tosoh Bioscience's first hardware offering for the bioprocess market.

IBO Stocks Remain Positive Despite Volatile US Market

The US markets continued the trend of volatility throughout the month of November. Investors were optimistic, hoping the upcoming G-20 summit, the mid-term elections, the jobs report and the annual Black Friday/Cyber Monday shopping event would boost the stock market.

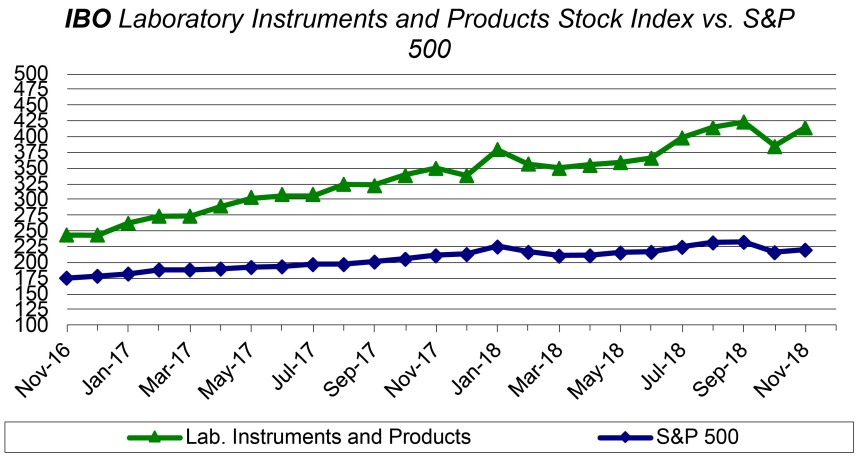
On November 2, the Bureau of Labor Statistics provided a positive October report highlighting a steady unemployment rate of 3.7%. In addition, on November 7, stocks rose after a consensus forecast from investors proved correct that showed Democrats winning the House, while the GOP kept control of the Senate.

However, by mid-November, the optimism was short-lived thanks to a major selloff in the technology sector, with markets closing in bear territory on November 19. This selloff renewed investors' concerns about a volatile US economy as they repositioned their portfolios to find alternative sectors to invest in, such as energy. Towards the end of the month, the Black Friday/Cyber Monday shopping event did not curtail investors' worries, as the US stock market experienced its worst performance during the Thanksgiving week since 2011. In addition, reports of the US raising tariffs on $200 billion of Chinese goods to 25% on January 1 raised concerns as well. The month ended on an uncertain note with the Commerce Department not revising its estimate of the 3.5% increase in the third quarter GDP on November 28, and the G-20 Summit beginning on November 30 and continuing through December.

On November 9, US oil prices slipped into a bearish market falling below $60 due to various factors such as oversupply of oil in the US, the softening of US oil sanctions in Iran, the slowdown of the global economy and the rising US dollar. At its lowest, oil prices slipped to $49.41 on November 29. On November 30, there was a slight increase of 2.3% to $51.45 as Russia met with Saudi Arabia, the leader of the Organization of the Petroleum Exporting Countries (OPEC), to cut production supply.

On November 28, the Federal Reserve confirmed that they were still going to raise interest rates in December but appeared uncertain about maintaining the quarterly increase scheduled for next year. The Fed stated its benchmark was "just below" neutral, meaning the banking system believed the US economy was not in a confirmed state of speeding up or slowing down. There were concerns about high-risk corporate debt and housing, yet encouragement with the strong numbers for consumer spending and disposable income. With this uncertain status of the US economy in mind, the Fed concluded it would be open to upcoming economic data to help shape future policies.

For the month, all three major stock indexes experienced slight gains. The Dow Jones Industrial Average was up 1.7%, the S&P 500 was up 1.8% and the NASDAQ was up 0.3%. Year to date, the Dow has risen 3.3%, the S&P 500 has gained 3.2% and the NASDAQ is up 6.2%.



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Laboratory Instruments and Products Stock Index

The *Index* rose 7.6% to 414 this month and is up 22.7% for the year. The *Index's* performance was solid with most companies experiencing gains except five of them. The worst performing company for the month was **Kewaunee Scientific**, declining 11.4%. The company that performed the best was **Pacific BioSciences**, with a 75.7% increase as Illumina announced plans to buy the company (See ***IBO 11/15/18***).

Reporting strong third quarter revenue, EPS and margins exceeding the company's expectations, on November 2, **Bruker** increased its full-year non-GAAP EPS guidance to $1.36–$1.40, a $0.02 boost from prior guidance, resulting in 12%–16% growth.

Mettler-Toledo, on November 4, reported fiscal third quarter financials and forecast fourth quarter adjusted EPS guidance to be $6.72–$6.77 resulting in 13% growth. The guidance was adjusted to reflect an expectation of local currency sales growth of about 6%. For the fiscal full-year 2018, the company increased its earnings guidance by 15% of $20.20–$20.25. As with the fourth quarter guidance, the full-year guidance was adjusted to reflect an expectation of local currency sales growth of about 6%. For full-year 2019 the company predicted its adjusted EPS guidance to be $22.40–$22.60, an 11%–12% increase due to an expectation of local currency growth of 5%.

On November 6, **Becton Dickinson (BD)** reported its fiscal fourth quarter financials and forecast fiscal 2019 adjusted EPS guidance to be $12.05–$12.15. The guidance was adjusted to reflect the company's projected revenue growth of 5%–6%. In quarterly dividend news, **BD** approved a 2.7% increase to its company's quarterly dividend. The stockholders will receive quarterly cash dividends of $0.77 per outstanding share instead of $0.75.

On November 14, **Agilent Technologies** announced its Board approved a 10.1% increase in the company's quarterly dividend. As a result, stockholders will receive a quarterly cash dividend of $0.16 per outstanding share up from $0.15. **Agilent Technologies** announced its fiscal fourth quarter results on November 19 and forecasted its fiscal 2019 non-GAAP EPS guidance to be $3.00–$3.50, resulting in 9%–11% growth. The company adjusted its non-GAAP EPS guidance to reflect less favorable foreign exchange.

On November 27, **MTS Systems** forecast a fiscal full-year 2019 GAAP diluted EPS of $2.30–$2.60, which would represent 20% growth.

The following companies did not provide EPS guidance: **Bio-Rad Laboratories, Fluidigm, Luminex, NanoString Technologies and Pacific Biosciences**.

In other news, on November 16**, Nanostring Technologies** entered an amended and reinstated $20 million Loan and Security Agreement with Silicon Valley Bank.

Company	Date Rep.	Fiscal Quarter	2018 Adj. EPS	Analyst Consensus	Vs. Estimate	YOY Growth	2017 Adj. EPS
Laboratory Instruments and Products Stock Index							
A	19-Nov	4Q	$0.81	$0.73	$0.08	20.9%	$0.67
BDX	21-Nov	4Q	$2.93	$2.92	$0.01	22.1%	$2.40
BIO	1-Nov	3Q	$0.91	$1.16	-$0.25	-10.8%	$1.02
BRKR	1-Nov	3Q	$0.37	$0.30	$0.07	27.6%	$0.29
FLDM	6-Nov	3Q	($0.38)	($0.38)	$0.00	-17.4%	($0.46)
LMNX	5-Nov	3Q	$0.05	$0.08	-$0.03	-61.5%	$0.13
MTD	8-Nov	3Q	$5.12	$4.99	$0.13	17.4%	$4.36
MTSC	26-Nov	4Q	$0.61	$0.69	-$0.08	38.6%	$0.44
NSTG	8-Nov	3Q	($0.56)	($0.60)	$0.04	24.4%	($0.45)
PACB	1-Nov	3Q	($0.19)	($0.16)	-$0.03	0.0%	($0.19)
Diversified Laboratory Stock Index							
AME	1-Nov	3Q	$0.82	$0.78	$0.04	24.2%	$0.66

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Diversified Laboratory Stock Index

The *Index* rose 5.3% in November to 271.64 and is slightly down 0.1% year to date. All the companies experienced gains. **Corning** gained the least, rising 0.8%, while **Xylem** was up the most, increasing 11.3%.

On November 1, **AMETEK** announced its fourth quarter guidance. The company forecast EPS of $0.82–$0.84, a 17%–20% increase from its previous guidance. In addition, the company projected fourth quarter sales to increase by 10%, with organic sales up mid-single digits. Also, **AMETEK** announced an amended and reinstated revolving $1.5 billion credit facility with a syndicate involving JP Morgan, Bank of America, Wells Fargo, PNC, SunTrust and five additional banks. The loan has a maturity date of October 2023, and proceeds will be used to finance company initiatives, including acquisitions.

In other news, on October 31, **Danaher** began the registration process of issuing two million common shares for its employee benefits plans. The total purchase price for the stock is expected to be up to $194 million. On November 12, **Roper Technologies** declared a quarterly dividend of $0.46, a 12.1% increase.

International Stocks

For the month, the Asia Pacific markets were mixed but with mostly positive gains. India's Sensex was up 3.38%, but China's Shanghai Index declined 3.30%.

Prices for the Pacific region companies in the ***IBO*** Stock Table were mixed this month with the most significant decline for **Hitachi High-Technologies**, sliding 4.9%. In contrast, **Precision System Science** experienced the greatest gains in the Table, rising 8.6%.

European equity markets were mostly down in October except for Spain's IBEX 35, rising 0.94%. The index that experienced the biggest loss was Germany's DAX with a 2.27% decline.

Prices for the European stocks in the ***IBO*** Stock Table were mixed, with many companies showing declines in November. **Spectris** was the biggest winner with an 11.7% increase. In contrast, **Horizon Discovery** was the biggest loser, registering a 12.3% decrease.

In other news, on November 5, **Biotage** updated its organic sales growth goal and EBIT goal: the company projected organic sales to grow 8%, while EBIT is projected to increase by 15%.

Company: Exchange	Market Value (US M)	52-Week Range Low ($)	High ($)	Price 11/30/2018	Change 1 Month	Change YTD	P/E (ttm)	EPS (ttm)
Laboratory Instruments and Products								
Agilent Technologies: n	$23,063	60.42	75.00	$72.35	11.7%	8.0%	26	2.79
Becton, Dickinson and Company: n	$67,802	209.91	265.87	$252.75	9.7%	18.1%	23	10.97
Bio-Rad Laboratories: n	$6,823	231.00	345.15	$274.46	0.6%	15.0%	53	5.22
Bio-Techne: o	$6,091	125.84	206.04	$161.42	-3.8%	24.6%	35	4.55
Bruker: o	$5,316	28.13	36.53	$33.14	5.8%	-3.4%	24	1.37
Enzo Biochem: n	$145	3.01	9.82	$3.08	-7.2%	-62.2%	NM	-0.21
Fluidigm: o	$322	4.65	8.69	$8.20	13.9%	39.2%	NM	-1.04
Harvard Bioscience: o	$144	3.05	6.70	$3.95	-0.3%	19.7%	21	0.19
Illumina: o	$49,613	207.51	372.61	$337.50	8.5%	54.5%	58	5.84
Kewaunee Scientific: o	$69	24.56	38.80	$25.35	-11.4%	-12.6%	15	1.64
Luminex: o	$1,310	18.62	35.37	$29.37	2.1%	49.1%	47	0.62
Mettler-Toledo: n	$15,945	521.79	697.26	$636.66	16.4%	2.8%	33	19.48
MTS Systems: o	$919	42.00	57.50	$51.45	8.7%	-4.2%	26	1.96
NanoString Technologies: o	$514	5.87	18.86	$17.27	12.1%	131.2%	NM	-2.45
Pacific Biosciences: o	$1,159	2.02	7.84	$7.82	75.7%	196.2%	NM	-0.74
PerkinElmer: n	$9,641	69.21	98.33	$87.06	0.7%	19.1%	26	3.41
QIAGEN: o	$8,029	30.64	39.45	$35.44	-2.4%	14.6%	26	1.37
Quanterix: o	$418	13.00	24.81	$18.74	7.0%	-4.1%	NM	-8.30
Thermo Fisher Scientific: n	$100,518	181.51	250.75	$249.55	6.8%	31.4%	23	10.66
Waters: n	$15,304	167.94	220.20	$198.58	4.7%	2.8%	25	7.97
Diversified Laboratory								
AMETEK: n	$17,044	64.91	81.92	$73.43	9.5%	1.3%	23	3.13
Corning: o	$25,789	26.11	36.56	$32.22	0.8%	0.7%	19	1.69
Danaher: n	$76,777	91.84	110.13	$109.54	10.2%	18.0%	25	4.43
Honeywell	$108,639	133.71	162.52	$146.75	1.3%	-4.3%	18	7.95
Illinois Tool Works: n	$46,631	119.38	179.07	$139.05	9.0%	-16.7%	19	7.47
Roper Technologies: n	$30,754	252.23	312.65	$297.59	5.2%	14.9%	26	11.29
Teledyne Technologies: n	$8,065	172.80	250.87	$224.58	1.5%	24.0%	26	8.53
Xylem: n	$13,109	63.71	82.44	$72.98	11.3%	7.0%	28	2.65
Laboratory Instruments and Products				$414.00	7.6%	22.7%	31	
Diversified Laboratory				$271.64	5.3%	-0.1%	23	
Dow Jones Industrial Average				25,538.46	1.7%	3.3%		
S&P 500				2,760.17	1.8%	3.2%		
NASDAQ Composite				7,330.54	0.3%	6.2%		
Region	Market Value	52-Week Range		Price	Change	Change	P/E	EPS
Company	(Local M)	Low (L)	High (L)	11/30/2018	1 Month	YTD	(ttm)	(ttm)
Pacific Shares								
GL Sciences: t	¥16,919	1,211	2,345	¥1,512	-1.7%	-29.5%	10	¥144.01
Hitachi High-Technologies: t	¥557,158	3,350	5,680	¥4,045	-4.9%	-14.8%	5	¥765.18
HORIBA: t	¥226,260	4,825	9,590	¥5,320	0.4%	-21.6%	5	¥1,032.02
JEOL: t	¥97,085	1,194	2,595	¥1,987	7.1%	211.0%	42	¥46.90
Precision System Science: os	¥8,115	273	728	¥330	8.6%	-50.1%	NA	-¥50.51
Shimadzu: t	¥785,770	2,434	3,670	¥2,654	-7.0%	3.6%	22	¥121.48
Techcomp: hk	HKD 892	1.55	5.20	¥3	0.0%	81.0%	NM	($0.01)
European Shares (London)								
Abcam: l	£2,330	952.50	1,588.00	£11.35	-5.4%	7.6%	38	£0.30
Halma: l	£5,209	1,136.00	1,507.00	£13.72	3.3%	8.9%	28	£0.50
Horizon Discovery: l	£264	128.00	264.00	£1.76	-12.3%	-26.9%	NA	-£0.14
Oxford Instruments: l	£543	676.00	1,116.00	£9.46	0.6%	11.2%	15	£0.61
Scientific Digital Imaging: l	£33	11.76	46.60	£0.37	-4.8%	49.0%	21	£0.02
Spectris: l	£2,765	1,933.00	2,957.00	£23.94	11.7%	-3.7%	24	£0.99
European Shares (Other)								
Biotage: st	SEK 7,506	68.40	145.00	SEK 116.00	-3.3%	38.1%	43	SEK 2.70
Datacolor: s	CHF 127	755.00	900.00	CHF 755.00	-5.0%	-10.1%	20	CHF 38.54
Merck KGaA: g	€ 12,624	75.26	98.52	€ 97.68	2.9%	8.8%	22	€ 4.46
Sartorius: g	€ 3,819	73.16	140.50	€ 102.00	-8.1%	35.2%	18	€ 5.64
Tecan: s	CHF 2,413	178.60	256.00	CHF 205.20	-9.7%	1.2%	65	CHF 3.18

Third Quarter Results: Agilent Technologies, Bio-Rad Laboratories, Bio-Techne, Bruker, Merck KGaA, QIAGEN and Shimadzu

Pharma and Biotech Drive Agilent Growth

Agilent Technologies' fiscal 2018 fourth quarter revenues included a 1.2% decline and 1.5% growth from currency and acquisitions, respectively. (See Bottom Line.) Consumables, services and informatics accounted for 56% of sales. For the full year, core revenue growth was 7.1%.

Agilent Technologies Q4 FY18				
	Rev. (M)	Chg.	Organic Chg.	% of Rev.
Total	$1,294	8.8%	8.5%	
Life Sciences & Applied Markets	$597	8.5%	9%	46%
Agilent CrossLab	$441	9.2%	9%	34%
Diagnostics & Genomics	$256	8.9%	5%	20%

Click to enlarge.

Agilent Technologies FY18				
	Rev. (M)	Chg.	Organic Chg.	% of Rev.
Total	$4,914	9.9%	7.1%	
Life Sciences & Applied Markets	$2,270	9.1%	7%	46%
Agilent CrossLab	$1,701	11.1%	8%	35%
Diagnostics & Genomics	$943	9.7%	5%	19%

Click to enlarge.

By end-market, pharmaceutical and environmental/forensics led Agilent's revenue growth, increasing double digits, while the chemical/energy business grew in the high single digits.

Pharmaceutical and biotech sales rose 14% to account for 29% of company sales, with growth in both small molecule and biopharma end-markets. Product lines showing strength included cell analysis and Nucleic Acids Solutions Division (NASD) products.

Chemical/energy sales grew 7% to make up 24% of company sales. Broad-based gains in both the Agilent CrossLab, and Life Science and Applied Markets divisions were led by strong sales in spectroscopy, LC-MS, and supplies and services.

Environmental/forensic sales grew 17% due to broad-based growth across both end-markets. Highlights included strong demand for Cobalt Raman spectroscopy by forensic customers and LC-MS and ICP-MS by environmental customers. This end-market accounted for 12% of company revenues.

Diagnostics and clinical sales increased 1%, which included strong growth for the genomics businesses, offset by soft sales in the pain management market. The market accounted for 15% of company sales.

Sales to academic and government customers increased 10% to account for 10% of company revenues. Sales were driven by strong demand in China and for LC and LC-MS instruments.

Sales to the food end-market were flat with a decline in instrument sales in China. The end-market accounted for 10% of company sales.

Agilent Technologies Q4 FY18		
	Chg.	% of Rev.
Americas	7.7%	47%
Europe	4.9%	38%
Asia Pacific	10.8%	15%
China and Hong Kong	15.5%	21%

Click to enlarge.

Geographically, Agilent saw broad-based gains across all regions. Chinese sales jumped 16% to make up 56% of Asia-Pacific sales. Chinese sales were led by strong growth in pharma, environmental/forensics, chemical/energy and academic end-markets. There was also improved revenues for the food end-market. The region also passed the $1 billion mark in sales. Other Asia and Japan revenue increased 12%.

Agilent Technologies Q4 FY18	
	% of Rev.
Instruments	44%
Con., Svcx., Informatics	56%

Click to enlarge.

Life Sciences and Applied Market Group revenue growth were broad-based driven by MS, chromatography and cell analysis sales. Sales for the Agilent CrossLab Group included high demand for both services and consumables.

Diagnostics and Genomics Group revenue growth was led by strong product sales for the NASD and genomics division.

Agilent Technologies Q4 FY18		
	Op. Margin	Chg. (bps)
Total	19.2%	-35.36
Life Sciences & Applied Markets	25.9%	210
Agilent CrossLab	24.7%	180
Diagnostics & Genomics	23.3%	180

Click to enlarge.

Agilent expected its fiscal 2019 core revenues to total $5.13–$5.17 billion with organic growth of 5%–5.5%. Agilent anticipates a currency headwind of roughly $110 million for 2019; however, the company expects the impact to be softened by M&A, including the recently closed ACEA Biosciences acquisition (see ***IBO*** 9/30/18). For first quarter guidance, Agilent forecast a revenue range of $1.26–$1.28 billion with organic growth of 4.5%–5.5%.

Bio-Rad Life Science Revenue Growth Excels Despite Significant RainDance Sales Decrease

Bio-Rad Laboratories Life Science Q3 FY18					
Rev. (M)	Chg.	Currency	Acq./Div.	Organic Chg.	% of Co. Rev.
$206.6	7.2%	2.0%	—	8.0%	38%

Click to enlarge.

Sales for Bio-Rad Laboratories' Life Science segment increased high single digits on an organic basis. (See ***IBO*** 11/15/18.) The business segment's revenue growth was driven by a double digit sales increase for its cell biology, digital PCR, Western blot and food safety products. Process media sales were up $8 million. Life Science quarterly revenue rose 8% on a currency neutral basis, and, excluding process media sales, grew about 6.5%. The business segment's quarterly revenue growth was offset by a $4 million decrease in sales of RainDance products. Excluding currency, Life Science experienced strong sales growth in North America, Europe, China and Brazil. Bio-Rad predicted that sales for Life Science may decline due to a tough comparison in the fourth quarter. The company forecast its full-year revenue to increase 4%–4.5%.

Protein Sciences Sales Leads Growth for Bio-Techne

Bio-Techne fiscal first quarter revenues grew double digits, led by Protein Sciences, which grew double digits organically. (See ***IBO*** 10/31/18.) The company made changes to its segment reporting for the fiscal year 2019. Bio-Techne now reports two business segments instead of three: Protein Sciences, and Diagnostics and Genomics. The Protein Sciences segment is a combination of the Protein Platform and Biotechnology segments. The Diagnostics and Genomics segment consists of the Diagnostics segment and Advanced Cell Diagnostics, which is now referred to as the Genomics division. All references to revenue growth by region or end-market exclude OEM sales which heavily impacted the Diagnostics and Genomics segment and, to a lesser extent, the Protein Sciences segment.

Bio-Techne Q1 FY19						
	Rev. (M)	Chg.	Acq./Div.	Currency	Organic Chg.	% of Rev.
Total	$163.0	12.7%	4%	1%	10.0%	
Protein Sciences	$126.4	16.9%	2%	1%	14.0%	78%
Diagnostics and Genomics	$36.7	0.4%	2%	—	-2.0%	23%
Intersegment	-$0.2	88.8%	—	—	—	—

Click to enlarge.

Geographically, Europe led the way in revenue growth with a reported 10% organic increase. Europe has become the most consistent region for Bio-Techne, averaging double-digit growth for the past two years. The company attributed this trend to its selling model of combining reagents with instruments to the academia and biopharma end-markets. This selling model has been applied to the US which resulted in a 10% organic growth for the region with the academia end-market leading in sales. Chinese sales experienced 30% organic growth with instruments and genomics leading sales. According to Bio-Techne, the trade dispute between the US and China has had minimal impact.1

Bio-Techne Q1 FY19		
	Adj. Op. Margin	Chg. (bps)
Total	35.1%	-192
Protein Sciences	43.2%	47
Diagnostics and Genomics	6.9%	-1299

Click to enlarge.

Protein Sciences' revenue growth was experienced across most product categories and geographic regions. Indeed, most product categories experienced double-digit sales increases. The strongest sales for the segment were mostly for protein and cell and gene therapy applications, and the Simple Western and Simple Plex instruments.

Despite having solid sales, Diagnostics and Genomics was affected by the timing of OEM orders. This led to a $1–$2 million revenue fall out. However, the Genomics division reported double-digit growth, led by the RUO end-market for which sales increased 30**%.** End-market wise, biopharma sales rose high single digits and academic sales grew in the high teens.

Bio-Techne Q1 FY19			
	Rev.	Chg.	% of Rev.
US	$90.5	14.2%	56%
EMEA, excl. UK	$35.2	12.2%	22%
UK	$7.1	2.9%	4%
APAC, excl. Greater China	$11.6	1.2%	7%
Greater China	$13.4	25.2%	8%
Rest of World	$5.1	19.4%	3%

Click to enlarge.

Fiscal 2019 sales are expected to be in the high single digits on an organic basis. The company's outlook on newly acquired Exosome Diagnostics (see ***IBO*** 06/30/18) regarding its revenue contribution is uncertain due to the pending approval of reimbursement coverage from Medicare and accrual-based accounting not being completed until at least the fourth quarter of fiscal 2019 or first quarter of fiscal 2020. Starting in fiscal year 2020, Bio-Techne hopes the division will begin a trajectory of hitting $150 million in annual revenue in fiscal year 2023.

Bruker's BSI Revenue Increase Despite Slowdowns in Europe and China

Third quarter Bruker Scientific Instrument (BSI) sales increased to make up 89% of company revenues. (See ***IBO*** 11/15/18.) Systems sales grew 5.1% to account for 71% of total revenues, while Aftermarket sales jumped 11.1%.

Bruker Q3 FY18					
	Rev. (M)	Chg.	Currency	Acq./Div.	Organic Chg
Total	$466.6	7.1%	-1.4%	1.5%	7.0%
Bruker Scientific Instruments	$417.1	6.8%	-1.3%	1.6%	6.5%

Click to enlarge.

All three BSI units reported revenue growth. BioSpin sales rose in the low single digits with growth in the clinical and applied markets, as well as the service business. In addition, both NMR systems and PCI divisions grew modestly.

CALID experienced a revenue increase in the high single digits due to the strong sales for the division's MS and molecular spectroscopy businesses. Daltonics' MS revenue experienced strong sales for both microbiology and life science. Biotyper instruments and consumables, and Optics products sales also increased. CALID's detection sales were sluggish.

Nano sales increased high single digits, which were attributed to the strong academic and industrial research demand for ADVANCE X-ray and nano-analysis products. Other highlights included AXS revenue growth which was driven by demand in both industrial materials research and academic research markets, as well as strong demand for Nano Surfaces and nano-analysis tools. Nano's semiconductor metrology revenue, which contributed 5% of Bruker's overall revenue, rose modestly due to sluggish sales of capital equipment in the second half of the year.

Bruker Q3 FY18		
	Rev. (M)	% of Rev.
Biospin	$139.5	30%
CALID	$134.6	29%
Nano	$143.0	31%
BEST	$50.9	11%

Click to enlarge.

By region, North American BSI sales were up high single digits, while Asia-Pacific sales were up mid- to high single digits. Though BSI orders in China were strong, the region's revenue was flat. In addition, there was minimal impact of the US-China trade dispute due to most Bruker products sold in China being manufactured in Europe. Bruker estimated that the Chinese tariffs impacted 3% of the company's overall revenue. Other highlights included overall strong sales in Japan, and increased sales in the academic end-market in the US. On the other hand, Europe's revenue growth slowed to mid-single digits.

Bruker Q3 FY18	
	Rev. (M)
US	$134.1
Germany	$44.9
Rest of Europe	$114.6
Asia Pacific	$134.4
Other	$38.6

Click to enlarge.

Bruker updated its full-year revenue guidance to the range of 6.5%–7%, including 4% organic revenue growth, from a previous estimate of 3.5%. Currency is expected to increase revenue growth by 1.5% thanks to the US dollar strengthening in comparison to other currencies, while acquisitions will add 1.5% growth.

Bruker Q3 FY18			
Adj. Op. Profit	Chg.	Adj. Op. Margin	Chg. (bps)
$83.3	26.6%	17.9%	199

Click to enlarge.

Asia-Pacific and Europe Lead in Process Solutions Sales for Merck KgaA

Merck KGaA Life Science represented 41% of total company sales in the third quarter. (See ***IBO*** 11/15/18.) Along with Healthcare, Life Science delivered high single-digit organic revenue growth. The business segment was moderately impacted by negative foreign exchange effects due to Latin American currencies such as the Argentinean peso and the Brazilian real.

Merck KGaA Life Science Q3 FY18					
	Rev. (M)	Chg.	Currency	Organic Growth	% of Rev.
Total	€ 1,527.4	8.5%	-1.4%	9.8%	
Process Solutions	€ 619.2	15.3%	-1.1%	16.3%	41%
Research Solutions	€ 499.8	2.9%	-1.4%	4.3%	33%
Applied Solutions	€ 408.4	5.9%	-1.9%	7.8%	27%

Click to enlarge.

Within the Life Science segment, Process Solutions posted the fastest growth rate, driven by bioprocessing sales in Asia-Pacific and Europe and high demand for biopharmaceutical manufacturing products. Overall, the Process Solutions division experienced a 30% revenue increase in Asia-Pacific. Applied Solutions' revenue growth was spurred by the Lab Water franchise, which grew 9% organically, thanks to the double-digit sales growth for the Mili-Q IQ platform.

Merck KGaA Life Science Q3 FY18			
Adj. Op. Profit (M)	Chg.	Adj. Op. Margin	Chg. (bps)
€ 460	8.0%	30.1%	-13.3

Click to enlarge.

Research Solutions' strong sales were attributed to the company's e-commerce platform, which helped sales in its chemistry and reagents product lines. Overall, the reagents product sales increased in the mid- to high single digits. Geographically, China was the leading region in Research Solutions sales with high single-digit growth.

Merck KGaA Life Science Q3 FY18				
	Rev. Chg.	Currency	Org. Growth	% of Rev.
Europe	7.9%	-0.3%	8.3%	34%
North America	7.3%	0.1%	7.1%	36%
Asia Pacific	15.0%	-1.7%	16.7%	25%
Latin America	-4.2%	-18.2%	14.0%	4%
Middle East & Africa	-10.4%	-1.6%	-8.8%	1%

Click to enlarge.

The company forecast Life Science sales to grow 7%–8% on an organic basis for 2018, compared to a previous estimate of 5%–6% organic growth.

Currency Headwind and Veterinary Testing Assays Disinvestment Impact QIAGEN Sales

QIAGEN reported solid third quarter sales growth. (See ***IBO*** 10/31/18.) All figures mentioned are in constant currency.

QIAGEN Q3 FY18				
	Rev. (M)	Chg.	Rev. Chg. Excl. Currency	% of Rev.
Total	$377.9	3.8%	6.5%	
Molecular Diagnostics	$189.0	5.1%	9%	50%
Academia	$82.7	3.8%	5%	22%
Pharma	$71.1	3.2%	5%	19%
Applied Testing	$35.1	-1.5%	1%	9%

Click to enlarge.

Instrument sales advanced due to high sales of QIAsymphony and the GeneReader NGS platform. Though expected, the recently launched QIAstat-Dx system only contributed less than one percentage point of revenue growth. Despite the initial slow sales, the company is expanding placements of the system in Europe, Asia and Africa. Despite solid sales, instrument sales were not impacted by the company transitioning way from third-party service contracts to QIAGEN instruments. Excluding revenues from third-party contracts, instrument sales growth was 24%.

Consumables and related revenues sales were stable thanks to the high double-digit increase for Molecular Diagnostics, Pharma and Academia customer segments. The Applied Testing customer segment only experienced low single-digit revenue growth. Revenue growth for consumables increased 6%.

QIAGEN Q3 FY18				
	Rev. Chg.	% of Rev.	Rev. Chg.	% of Rev.
	Consumables and Related		Instruments	
Total	3.2%	88%	8.5%	12%
Molecular Diagnostics	4.7%	44%	8%	6%
Academia	0.5%	19%	-8%	3%
Pharma	3.7%	17%	-1%	2%
Applied Testing	0.3%	7%	34%	2%

Click to enlarge.

Molecular Diagnostics posted the fastest sales growth among the company's four customer segments. Strong sales growth was attributed to double-digit growth in instrument sales and high single-digit growth in consumables revenues.

QIAGEN Q3 FY18			
	Rev. Chg.	Rev. Chg. Excl. Currency	% of Rev.
Americas	8.0%	9%	49%
Europe/Middle East/Africa	-5.1%	1%	29%
Asia-Pacific/Japan	8.3%	21%	21%

Click to enlarge.

Applied Test sales were impacted by the disinvestment of some veterinary testing assays; however, the segment's sales were solid for the human ID and forensic division. Pharma and Academia sales both grew in the low single digits.

QIAGEN Q3 FY18			
Adj. Op. Profit ($M)	Chg.	Adj. Op. Margin	Chg. (bps)
$106	7.9%	27.9%	105

Click to enlarge.

Geographically, in the Americas, the company highlighted double-digit gains for the US and Mexico while Brazil and Canada experienced single-digit gains. These strong gains were spurred by Molecular Diagnostics and Academia sales.

Europe/Middle East/Africa was the region most impacted by the disinvestment of the veterinary assay business. Even though there were stable sales in Germany, Switzerland and Italy, the regions were offset by weak sales in France, the Benelux region and the Middle East. Sales in Turkey were up double digits but were impacted by currency headwinds.

Asia-Pacific sales growth was affected by last year's South Korean tenders for QuantiFERON-TB. Excluding this, Asia-Pacific sales were up 11%. In addition, China experienced double-digit sales growth and Japan began to show improvement after a lull in sales.

The company fourth quarter sales forecast was increased 6%–7%, with currency subtracting 4% growth. The company maintained its full-year guidance of an increase of 6%–7% with a 1% currency headwind.

Environmental Measurement Instruments Lead Shimadzu Sales

Shimadzu Analytical & Measuring Instruments' (AMI) first-half 2019 sales rose 6.8% to make up 61% of total company revenues. (See ***IBO*** 11/15/18.)

Shimadzu AMI H1 FY19		
	Rev. (B)	% Chg.
Total	¥111.1	6.7%
Key Models	¥59.5	13.0%
Other	¥51.6	2.0%

Click to enlarge.

By product line, revenue growth was led by sales of environmental measurement instruments, particularly in China, but also for spectroscopy and GC sales. Geographically, LC and MS sales showed strength in North America and Europe but sales of both product lines in Japan stalled. China also saw sluggish sales for LC products. Product wise, Q-TOF MS sold strongly but was offset by soft sales of the LCMS-9030, which had high inquiries from customers but were slow to finalize sales. As for GC, geographically, sales rose significantly in China, while product wise, the GC-2030 showed strong sales growth. SP product sales increased worldwide.

Shimadzu AMI H1 FY19	
	% of Rev.
Academic/Govt.	14%
Materials/Machinery/ Electrical/Automotive	21%
Pharma/CRO/Health Care/Foods	31%
Other	34%

Click to enlarge.

By end-market, sales to the three main sectors remained stable. In the pharmaceuticals/contract analysis/healthcare/foods category, contract analysis sales grew while sales to other fields were slightly sluggish. In the materials/machinery/electrical/automotive category, the materials field had strong sales, but sales decreased for the other fields. In Japan, sales to the academic market decreased. Government demand increased to 40% of sales in China, in comparison to the previous half of 31%. This was attributed to the region's pending government projects. Also, with China adopting the RoHS 2.0 Directive, demand for Shimadzu EDX and GC/MS systems rose. Sales in the Other category increased due to the expansion of the analytical instrument customer base.

Shimadzu AMI H1 FY19			
	% of Rev.	Chg.	Local Currency Chg.
Japan	47%	4.8%	4.9%
Americas	14%	10.7%	11.4%
Europe	8%	16.8%	14.2%
China	20%	8.5%	9.4%
Other Asia	9%	-0.6%	-0.5%
Other	3%	-9.8%	-8.0%

Click to enlarge.

Sales outside of Japan represented 61% of AMI revenue. Geographically, North American sales rose 13.2% in local currency to ¥22.3 billion ($196.1 million = ¥113.68 = $1). South American sales declined 7.1% in local currency to ¥2.6 billion ($22.9 million). Shimadzu also predicted that the revenue impact of the trade dispute between the US and China would not be felt until next year.

Shimadzu AMI H1 FY19				
Op. Profit	Chg.	Local Currency Chg.	Op. Margin	Chg. (bps)
¥15.6	8.3%	7.5%	8.5%	17

Click to enlarge.

For fiscal year 2019, the sales growth forecast remains the same with a 9.4% increased bolstered by changes in currency effects.

Droplet-Based Single-Cell Analyzers

Single-cell analysis enables the investigation of characteristics of individual cells in a homogeneous population, facilitating genomic, transcriptomic, proteomic and metabolomic studies at the single-cell level. By studying individual cells in a heterogeneous mixture, it is possible to examine rare cell types and to make discoveries that

would be difficult to see in a bulk cell population.

With growing applications in research and medicine, multiple technologies have emerged for the collection and/or analysis of individual cells with characteristics of interest. Each technology is suited for a subset of research and production applications. Droplet-based cell analysis is most often associated with transcriptome analysis through the sequencing of RNA. This enables analysis of which genes are being expressed at a given time at single-cell resolution, and can provide insights into disease, physiology and immunology. RNA is not as stable as DNA and is more sensitive to degradation. Droplet-based cell analyzers are able to process cells quickly and gently to maintain native expression profiles.

Droplet-based single-cell analysis technology is relatively new, with the first commercial systems released in 2016. The principles behind the high-throughput sequencing of RNA from single cells originate from a method developed at Harvard University. The technology facilitates preparation of over 15,000 cells per hour.

While each instrument on the market varies in its approach, they share some common characteristics. The instruments use chip-based microfluidics technologies to generate aqueous droplets in the picolitre-volume range and micron-sized; each droplet encapsulates a single cell. The systems and their respective protocols each incorporate reverse transcription and barcoding. Reverse transcription, which is performed by the enzyme reverse transcriptase (RT), makes cDNA copies of RNA. This is a typical step in RNA analysis, as current DNA sequencing technology is far more advanced than RNA sequencing.

Barcoding incorporates a unique molecular identifier (UMI) onto reverse transcription primers, so that the resulting cDNA sequences from each cell can be differentiated in downstream analysis. Barcoded primers are generally encapsulated together with a cell in a droplet, where ligation of the primer to the RNA takes place. Depending of the instruments, the reverse transcription reaction takes place either within the droplet (in which case RT is also encapsulated) or after the droplet is broken. Most systems do not incorporate sequencing functions, requiring subsequent sequencing using a dedicated sequencer.

Only a handful of companies currently participate in the droplet-based single-cell analysis market. 1CellBio, which was the first to market with its InDrop system, is a spinout from Harvard University. Other available instruments are the Chromium System from 10x Genomics, the Nadia System from Dolomite Bio, and the Single-Cell Sequencing Solution, which is a collaborative effort between Illumina and Bio-Rad Laboratories.

Droplet-Based Single-Cell Analyzers at a Glance:

Leading Vendors

- 10x Genomics
- Illumina/Bio-Rad Laboratories (collaboration)
- 1CellBio
- Dolomite Bio

Largest Markets

- Academia
- Pharmaceutical and Biotechnology
- Hospital and Clinical

Academia

US higher education R&D (HERD) expenditures increased in FY17, reaching $75.3 billion, a 4.7% increase, according to the HERD Survey by the NSF's National Center for Science and Engineering Statistics. This Survey consisted of 903 institutions that granted degrees and spent a minimum of $150,000 on R&D during the fiscal year. Federal R&D funding for universities has grown over the past two years, a first since 2009–2011, increasing

1.7% to $40.3 billion in FY17, while nonfederal funding rose 3.7% to $34.9 billion.

The numbers presented below are based on subset of survey results of 644 institutions performing at least $1 million in R&D annually. Of the total university R&D funding, $46.5 billion was allocated to basic research, $21.5 billion for applied research and experimental development received $7.2 billion, representing 62%, 29% and 10% of total university R&D funding, respectively.

The federal government represented nearly the same share of total university R&D funding as the previous year at 54%, which is the lowest share since the survey's inception in 1953. Federal funding rose 3.7% in FY17 in constant dollars.

Universities' own funding sources were instrumental to HERD funding in FY17, providing $18.9 billion in funding, a 5.1% increase, and representing 25% of total university HERD and 54% of overall nonfederal funding. Additionally, nearly $12.1 billion, or 67%, of institutional spending came from universities' own research accounts, which directly fund R&D activities. Unrecovered indirect costs, defined as "the amount of indirect costs that are not reimbursed to the institution for externally funded R&D," were flat at $5.2 billion, while cost sharing commitments totaled $1.6 billion, up 6.7%.

Business funding for university R&D also rose in FY17, growing 5.1% to $4.4 billion, while state and local governments provided $4.2 billion, a 5.3% increase. University R&D funding from undifferentiated sources, such as foreign governments, other educational institutes, or donor gifts for research, grew 3.2% to $2.3 billion. Nonprofit organizations contributed $5.1 billion to HERD funding in FY17, the largest increase in funding of all nonfederal sources at 10.9%.

HERD expenditures for science R&D reached $58.9 billion, growing 4.7%. Specifically, life sciences HERD expenditures, which includes the fields of agricultural, biological and biomedical, and health sciences, as well as natural resources and conservation, jumped 5.4%. Chemistry and materials science HERD totaled $1.8 billion and $227.7 million, growing 1.0% and 31.4%, respectively.

Source: *NSF*

Pharmaceuticals

Advances in blood cancer treatment, specifically CAR-T therapy, are transitioning to targeting solid tumors that contain specific molecular signatures. Companies such as Novartis and Celgene have helped accelerate CAR-T research with their portfolios of possible therapies for multiple cancer indications. Celgene recently added to its lymphoma program JCAR017, which is a CD19-directed CAR-T product for relapsed or refractory diffuse large B-cell lymphoma (DLBCL). Peak sales of the drug, which the FDA may approve in 2019, are forecast to be approximately $3 billion.

Generally, such therapies for solid tumors are challenging to develop since the tumors are in a hostile environment that keeps CAR-T cells from entering the surroundings. Also, it can be difficult to determine the location of proteins on tumor cells that are not present in the normal tissue.

Adoptive cell transfer (ACT) is another type of therapy that targets solid tumors, as are TCR-engineered T cells. Present in T cells, TCRs are natural receptors that can recognize proteins that are not in the plasma membrane, which is key for CARs. RXi Pharmaceuticals and Tarveda Therapeutics are among the companies leading advancements in this area.

Hospitals, academic institutions and medical centers are leading CAR-T development efforts, with 362 clinical trials. The NIH and National Cancer Institute are conducting 84 trials, while University Pennsylvania is involved in 37. Other organizations accelerating CAR-T development include Baylor College of Medicine, City of Hope Comprehensive Cancer Center and Texas Children's Hospitals, as well as companies such as Gilead Sciences/Kite Pharma, Takara Bio and Bellicum Pharmaceuticals.

Source: *PharmExec*

Genomics

In a recent study of people of African descent, scientists have uncovered new segments of DNA that may represent new genes, segments that had been ignored previously. In 1997, the Human Genome Project completed the first human genome sample, with 70% of the first DNA sample coming from a single person, referred to as RP11. Since then, this first human genome has been undergoing a perpetual refinement process, with additional sequences from other individuals added. It has been used as a reference genome, a standard that nearly all other human DNA that has been sequenced is compared to, even though the vast majority of this reference genome is still from RP11. Since genetic codes are unique, using the RP11 reference genome as a standard for all humans has resulted in biases within genetics research.

The new study has informed scientists just how limited the RP11 reference genome is. From over the 910 people's DNA that was studied, 300 million letters of DNA emerged in 125,715 separate DNA segments that are not in the RP11 reference genome. As people of African descent are genetically diverse, their DNA is least likely to match up to the reference genome, even though scientists have postulated that RP11 was possibly African American as well. However, using a single reference genome to represent the total human population has proved to be limited and incomplete.

Currently, DNA sequencers separate a genome into short segments that are "read" and then put together with algorithms using the reference genome to determine where each segment belongs. If a new segment arises that differs from the reference genome, the algorithms and scientists usually ignore it. But scientists are now working to better understand large structural variations to improve upon the Human Genome Project and other genetic studies.

Source: *The Atlantic*

Argentina

Federal budget cuts have greatly trimmed research funding in Argentina, with many academics reporting they are unable to afford publication costs to feature their work in paid scientific journals. The lack of research publications consequently lessens the impact of the scientists' work, and therefore they have less access to international collaborations that could help boost the nation's scientific research output.

In 2018's federal budget, approximately ARS 35 billion ($1 billion) was allocated to science and technology, only 1.2% of Argentina's overall budget. Publishing in indexed scientific journals, which are featured in internationally accessible databases, can cost up to ANR 177.4 thousand ($5 thousand). For scientists in Argentina, most of whom must pay for their own supplies in dollars while their grants are paid in pesos, the fees are largely unaffordable.

Over one hundred countries receive fee waivers or reductions from PLOS, which is a group of major scientific journals, but Argentina is not a part of this group. While Argentina has many scientific journals, most are not indexed, as the process to index a journal can be expensive. Researchers stated that instead of increasing funding for grants, it would be more effective for the publishing sector to establish free journals for scientists' access.

Source: *Global Press Journal*

UK

Business enterprise R&D (BERD) in the UK continues its upward rise, growing 4.9% in 2017 to £23.7 billion ($30.4 billion). In constant price terms, such expenditures have a CAGR of 4.3% since 1993. In 2017, total BERD accounted for 1.1% of the country's GDP.

Pharmaceuticals continued to be the largest BERD "product group." A product group is defined as "the type of research and development (R&D) performed, in contrast to the industry classification of the business performing the R&D." Pharmaceuticals reported 2017 expenditures of £4.3 billion ($5.5 billion), a 6.0% increase, to represent 18% of total BERD. The R&D services product group's R&D spending expanded 8.3% to £1.1 billion ($1.4 billion). But the chemicals and chemical products category's BERD dropped 14.5% to £870 million (1.1 billion). Software development was the product group with the fastest BERD increase in 2017, jumping 34.7% to £1.4 billion ($1.8 billion). Classified by industry, scientific R&D had the greatest BERD levels in 2017 at £5.4 billion ($6.9 billion), a 1.2% increase to 23% of total BERD, compared to 24% in 2017.

By funding source, self-funding represented 75% of BERD in 2017, or £17.7 billion ($22.7 billion), a 6.7% rise. In contrast, foreign R&D funding for UK businesses declined 7.4%, including a 50.5% drop in grants from the European Commission, to make up 14% of total UK BERD funding. Government funding for business R&D grew 5.8% last year to represent 8%.

UK businesses' number of full-time equivalent R&D employees grew 7.4% in 2017 to 215,000, with 49% classified as researchers., compared to 45% in 2016.

Source: *UK Office for National Statistics*

Africa

According to a pan-African international study funded by the Robert Bosch Stiftung Foundation in Germany and the International Development Research Center in Canada, the majority of research conducted in Africa is still financed by European, US and Chinese agencies. As a result, these publications are more likely to publish the results of international collaborations than of local research organizations. The study took place over 4 years and surveyed 5,700 African researchers.

Data in the study indicated that the EU, the US NIH and UK's Wellcome Trust operate as the biggest funders of African research. Also included in the top 10 were the Bill & Melinda Gates Foundation, DFG, a German research-funding agency, as well as Spain's federal government. Only two African organizations—South Africa's National Research Foundation, which headed the list, and the Ministry of Higher Education and Scientific Research in Tunisia—made the top 10.

Due to the lack of national funding agencies on the African continent, many countries in Africa are highly reliant on international funding. Scientists receiving over half of their research funding from foreign sources received more funding on average than scientists that primarily received national funding. For example, on average, the surveyed scientists' reported funding over 3 years of $5,000, but 128 researchers heavily dependent on international funding reported receiving funding support of over $1 million. Most of these 128 respondents were largely based in Kenya, South Africa, Uganda and Zambia, and work in the health or natural sciences. Additionally, certain fields, such as agriculture and health sciences, have simpler access to funding,

Data in the report illustrate that scientists on the continent have more than tripled their scientific output between 2005 and 2016, from 15,000 research papers to 54,000, respectively. In addition, Africa's share of global scientific output has reached 3.2%.

Source: *Nature*

Life Science Consumables

Company Announcements

For the fiscal year ending July 31, **Enzo Biochem**'s Life Sciences Products sales were flat at $29.2 million, or 28%

of total revenues (see ***IBO*** *10/31/18*), as royalty income and US sales declined. The company continues to migrate its Life Sciences business from a provider of research products to a developer of lower-cost diagnostic products. The company reported cash and cash equivalents of $60.0 million.

In October, **Stream Bio** named **CliniSciences** and **Biotrend** as distributors for France and Germany, respectively, for its Conjugated Polymer Nanoparticles, which are fluorescent, non-toxic nanoparticles for bioimaging.

Gene-based Analysis

Company Analysis

In October, **LuminUltra** acquired **acqu-tools' Rapid Microbial Solutions** division, which supplies the B-QUA product for ballast water compliance monitoring and measures biomass of three micro-organisms. LuminUltra also assumed responsibility for the sale of acqu-tool's second generation ATP (adenosine triphosphate) measurement products in Europe.

ERS Genomics licensed its CRISPR-Cas9 genome editing IP to **Syngulon**, a synthetic biology company developing anti-microbial peptides, in October for use in combination with Syngulon Patent Rights.

In November, **ERS Genomics** licensed access to its CRISPR/Cas9 genome editing technology patents to **DefiniGEN**, provider of a stem cell production platform, for combination with DefiniGEN's iPSC differentiation platform.

In October, the **National Center for Tumor Diseases Heidelberg** and **Protagen** announced a collaboration to utilize Protagen's Cancer Immunotherapy Array to identify biomarkers that predict therapeutic response and the incidence of immune-related adverse events in urothelial carcinoma patients treated with checkpoint inhibitors.

Synthego, which provides genome editing tools, closed a $110 million Series C investment in October led by **Founders Fund**.

In November, **Synthego** named **Eurofins Genomics** as a distributor of its sgRNA products.

In October, **Twist Bioscience** named Ray Tabibiazar, MD, as senior vice president of Corporate Development and Business Strategy, as well as acting general manager of Twist Bioscience's division focused on biologics drug discovery. He previously worked as an advisor to the company and was previously chairman of **Aravive Biologics**.

Twist Bioscience named Jan Johannessen to its Board in November. Previously, he served as CEO of semiconductor firm **Conexant Systems**.

LGC Biosearch Technologies exclusively licensed in October **Co-Diagnostics**' CoPrimer technology for research and commercial applications. A joint development project tested the PCR-based technology in multiplexed reactions for locating specific genetic traits in seed products and genetic mutations, including SNP detection.

In October, **XCR Diagnostics** licensed its Xtreme Chain Reaction nucleic acid amplification technology to **Luminex**. The technology enables extremely rapid thermal cycling protocols.

Ncardia, which provides human iPSC–based solutions for drug safety and efficacy screening, partnered with **Horizon Discovery** in October to provide custom genetically modified and differentiated human iPSCs for drug discovery researchers. Ncardia will market and sell the products and services.

Horizon Discovery appointed of Margarita Krivitski, vice president at **ValueAct Capital Management**, to its Board in November. ValueAct holds a 13% stake in Horizon Discovery.

In November, gene editing technology firm **Inscripta** named Jason T. Gammack as its first chief commercial officer. He was most recently vice president of **QIAGEN**'s life science business area.

DNA Script, an enzymatic DNA synthesis company, created a US subsidiary in November.

In November, **Oxford Gene Technology**, a **Sysmex** company, expanded direct sales of its Cytocell FISH products to include Asia Pacific.

Product Introductions

In October, **PathogenDx** introduced PDx-Quant, calling it the first quantitative microarray-based test for microbial testing of cannabis.

QIAGEN launched in October in Europe its next generation QIAstat-Dx panel for one-step, fully integrated molecular analysis of gastrointestinal syndromes. The panel can now detect the 24 most common viral, bacterial and parasitic pathogens. The test is CE-IVD marked, and the company expects US **FDA** approval in 2019.

In November, **ThermaGenix** released FASTFISHID, a low-cost, portable PCR test for the authentication of commercial fish species. The test is fully compatible with the **FDA**-approved "DNA Barcoding Method for the Species Identification."

Sarstedt debuted in November low-profile PCR strips, also known as 0.1 mL PCR strips, for so-called fast PCR thermocyclers (0.1 mL block format).

Cell-based Analysis

Company Announcements

In November, **InDevR**, a **Sartorius** company, announced it is pursuing proof-of-concept development sponsored by the **Bill & Melinda Gates Foundation** for new VaxArray potency assays for measles and rubella (MR) vaccines. The long-term objective is to create IV measles and rubella potency assays in order to deliver high-quality MR vaccines to market faster and with lower production costs.

Product Introductions

In November, **ibidi** introduced the mRNA LifeActTagGFP2, a rapid, noninvasive and nontoxic solution for the visualization of filamentous actin (Factin) in living and fixed eukaryotic cells.

Protein-based Analysis

Company Announcements

In October, **Bio-Techne** entered into a strategic cooperation agreement with China-based **Micropoint Bioscience**, a developer of a microfluidic diagnostic chip for point-of-care testing. The companies will develop solutions for monitoring patients' responses to cancer immunotherapy and identifying potential adverse effects, such as the cytokine release syndrome.

In November, **GeneTex**, a research antibody manufacturer, partnered with **BenchSci**, a life science machine learning startup backed by **Google**'s AI fund. BenchSci will use machine learning to identify published data for individual GeneTex products in open- and closed-access datasets, display related published figures and allow researchers to search using important experimental variables.

Product Introductions

In October, **Charm Sciences** released the MycoTube Portable Aflatoxin Screening test, calling it the only five minute field test for detection of aflatoxin in grains and feed.

In November, **Ultivue**, a developer of reagent-driven strategies for high-performance biological imaging in situ, expanded the capabilities of its proprietary InSituPlex DNA-barcoding and staining technology, which now supports a 9-color/8-marker whole-slide, a single staining step multiplexing assay for multiplexed detection and quantification

of markers in tissue samples.

Surface Science

Company Announcements

AMETEK's EDAX business announced in September a collaboration with analytical service lab **Covalent Metrology** on the application of energy-dispersive spectroscopy (EDS) for the quantified characterization of a wide variety of materials. Covalent will employ the EDAX 70mm Octane Elect Super EDS System equipped with advanced APEX software. EDAX will rely on Covalent Metrology's laboratory as a Silicon Valley demonstration center for customers interested in evaluating and potentially purchasing EDAX EDS systems,

In October, **Henniker** completed its relocation to Runcorn, UK, tripling its manufacturing space and adding a new R&D lab.

Thorlabs announced in November a licensing agreement with **Howard Hughes Medical Institute** (HHMI) for exclusive rights to a new bessel beam-based, multiphoton volume imaging technique originally developed at HHMI's Janelia Research Campus in the lab of Dr. Na Ji. The imaging technique features temporal resolution adequate for studying neuronal systems' internal dynamics at cellular lateral resolution. The multiphoton volume imaging technique is offered as an add-on module for Thorlabs' Multiphoton Mesoscope and Bergamo (either 2 photon or 3 photon) imaging systems.

In November, **Park Systems** officially opened its Beijing office, which is equipped with a Park NX10 AFM system. The office will provide direct support. The company also has an office in Shanghai.

Product Introductions

In September, **Media Cybernetics** announced Network Server Licenses for its ImagePro image analysis software platform. The Network Server License allows multiple seats of ImagePro to be independently configured and managed through a license server hosted on an internal network.

Tomocube launched in September the HT-1 high-resolution holotomography microscope for generating 3D holographic images of unlabeled live cells. Samples require no labeling or preparation.

In October, **Nikon** introduced the CFI S Plan Fluor LWD 20XC and CFI S Plan Fluor LWD ADM 20XC objectives. The CFI S Plan Fluor LWD 20XC is suitable for brightfield, fluorescence and differential interference contrast observation. The CFI S Plan Fluor LWD ADM 20XC can be used for brightfield, fluorescence and phase-contrast observation They feature a working distance of 1.3–2.3 mm.

Nikon launched in November the CFI90 20XC Glyc microscope objective, which is capable of deep imaging of whole, cleared tissues. It combines a large field of view, high numerical aperture and an 8.2 mm working distance.

Olympus released in November the SpinSR10 super-resolution microscope, which combines 0.005 sec/frame acquisition speed and 120 nm super resolution with improvements that provide clearer images and three times the brightness of the standard SpinSR10 model.

In November, **DRVISION** announced the launch of Aivia Cloud, a usable AI platform for scientific imaging applications. designed for training and deployment of deep learning models.

Bruker introduced in November the *AFM-nDMA* mode for its Dimension AFM, stating that it provides the first and only nanoscale viscoelastic measurements that match bulk dynamic mechanical analysis over the entire frequency range typical in bulk rheological measurements.

In November, **Bruker** debuted the *Dimension XR* family of SPMs, available in three configurations optimized for

nanomechanics, nanoelectrical and nanoelectrochemical applications. The *Dimension XR* systems are available on either the Icon or FastScan AFM platform

Digital Surf and **Image Metrology** announced that MountainsSPIP 8 software for SPM image analysis will be available in the second quarter of 2019. The software combining the companies' respective Mountains and SPIP platforms into a single platform. Applications include interactive particle analysis, force spectroscopy and correlative analysis.

Sales and Orders of Note

In November, **Thermo Fisher Scientific** announced that the UK-based **Cambridge Pharmaceutical Cryo-EM Consortium** is adding another Thermo Fisher Krios G3i Cryo-TEM system. The latest will be housed at the **University of Cambridge, Department of Materials and Metallurgy**, and will be used to explore innovative applications of cryo-electron microscopy in materials research.

Confocal.nl announced in November that Professor Markus Sauer at the **University of Würzburg** has integrated the company's Re-scan Confocal Microscopy module with a single-molecule dSTROM setup, resulting in resolution of around 20 nm.

Materials Characterization

Company Announcements

In September, **Instron** announced that its Calibration Laboratory in Norwood, Massachusetts, has expanded its global reach to include Europe. This addition enables Instron to provide accredited calibration services in North America, Europe and Asia under a single **National Voluntary Laboratory Accreditation Program** (NVLAP) accreditation.

Product Introductions

In September, **IKA** launched the ROTAVISC series of viscometers, featuring four new models for different viscosity ranges.

Mettler-Toledo introduced in September the Density Excellence models D4, D5 and D6, and the Refractometry Excellence models R4 and R5. Measurements include up to 6 decimal places in density and up to 5 in refractive index.

In October, **Anton Paar** introduced the Diana 700 for automatically performing high-precision distillation range analysis at atmospheric pressure. The intelligent condition monitoring system controls all steps that are necessary to perform a distillation and only allows a start if every step was completed successfully.

AD Systems & DC Scientific released in October the TO10 thermal oxidation stability test rig, featuring control of the thermal profile of the heater tube.

Sales and Orders of Note

In October, **Particle Testing Authority** (PTA), a division of **Micromeritics Instrument**, acquired a **Freeman Technologies**' FT4 Powder Rheometer for assisting its contract testing customers with their powder flow and powder processing issues. Freeman Technologies is a division of Micromeritics.

Particle Testing Authority acquired in October a **Malvern Panalytical** Mastersizer 3000 particle sizing system.

Sample Preparation

Company Announcements

In October, **Arcis Biotechnology**, a nucleic acid sample preparation solution provider, closed a £1.25 million ($1.64 million) investment round and a decision to overfund by an additional £0.5 million ($0.7 million), via specialist life sciences equity crowdfunding platform **Capital Cell**.

Arcis Biotechnology signed a technology access agreement in October with **Teleflex** for the development of a new technology.

In November, **Pressure BioSciences** appointed Dr. Bradford A. Young as senior vice president and CCO. Prior positions include founder and CEO of biotechnology firm **AddisonField**.

Metrohm Australia announced in November that it is the exclusive distributor of **Milestone**'s microwave technology in Australia.

Product Introductions

In November, **CEM** introduced the MARSXpress Disposable Liners for its MARS 6 microwave digestion systems. The liners eliminate the need to clean the digestion vessel between runs.

Sales and Orders of Note

In September, biotech firm **Genentech** licensed **Cell Signaling Technology**'s PTMScan technology for discovery proteomics research. CST PTMScan technology is an immunoaffinity enrichment method for the discovery of hundreds to thousands of novel sites of post-translational modifications.

Reported Financial Results

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