Zacks Small-Cap Research

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Protea Biosciences Group (PRGB-OTCBB)

PRGB: Services Business Driving Top-Line Growth

Current Recommendation	**Outperform**
Prior Recommendation	N/A
Date of Last Change	07/29/2014
Current Price (02/17/15)	$0.60
Target Price	**$1.80**

OUTLOOK

Protea is at the initial stages of the roll-out of its revolutionary LAESI technology which is used with mass spectrometry and which has substantive advantages over traditional ionization methods. Commercialization of the LAESI instruments is being complemented with the company's molecular information services offerings and collaborations with leading medical institutions and industry partners. These current and additional partnerships and collaborations are expected to help build awareness of LAESI and Protea's capabilities and eventually lead to new product launches and services offerings. With 20+ new customer wins since just 2013, meaningful services-related revenue already booked in 2014, additional services-related sales reps recently hired and consummation of additional collaborative agreements, we think the services business is poised to show a rapidly steepening revenue curve.

SUMMARY DATA

52-Week High	**$5.00**
52-Week Low	**$0.20**
One-Year Return (%)	**N/A**
Beta	**N/A**
Average Daily Volume (sh)	**2,287**
Shares Outstanding (mil)	**67**
Market Capitalization ($mil)	**$40**
Short Interest Ratio (days)	**N/A**
Institutional Ownership (%)	**0**
Insider Ownership (%)	**58**
Annual Cash Dividend	**$0.00**
Dividend Yield (%)	**0.00**
5-Yr. Historical Growth Rates	
Sales (%)	**N/A**
Earnings Per Share (%)	**N/A**
Dividend (%)	**N/A**
P/E using TTM EPS	**N/A**
P/E using 2015 Estimate	**N/A**
P/E using 2016 Estimate	**N/A**
Zacks Rank	**N/A**

Risk Level	**High,**
Type of Stock	**N/A**
Industry	**Med Info Sys**
Zacks Rank in Industry	**N/A**

ZACKS ESTIMATES

Revenue
(in 000s of $)

	Q1 (Mar)	Q2 (Jun)	Q3 (Sep)	Q4 (Dec)	Year (Dec)
2014	468 A	347 A	518 A	436 A	1768 A
2015	519 E	819 E	1227 E	1632 E	4197 E
2016					9748 E
2017					14773 E

Earnings per Share

	Q1 (Mar)	Q2 (Jun)	Q3 (Sep)	Q4 (Dec)	Year (Dec)
2014	-$0.04 A	-$0.05 A	-$0.07 A	-$0.03 A	-$0.17 A
2015	-$0.03 E	-$0.02 E	-$0.02 E	-$0.02 E	-$0.09 E
2016					-$0.06 E
2017					-$0.04 E

Zacks Projected EPS Growth Rate - Next 5 Years % **N/A**

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WHAT'S NEW….

Full Year 2014 Results: Mostly In-Line With Our Estimates, Services Biz Picking Up Steam…

Protea filed their 10-K for the full-year ending December 31. While the top-line was slightly softer than our estimate, this was offset by lower OpEx – the net result was operating loss coming in just about dead-on with our forecast. Importantly, the top-line miss was mostly a result of lower than modeled LAESI instrument sales – as opposed to services revenue.

The services business, where we expect the majority of the fuel for long-term revenue growth and expanding margins, has already been a major contributor to top-line growth. While LAESI instrument revenue increased 14% in 2014, services-related revenue (i.e. – "Molecular Information Services") grew by 154%. And as the services segment commands significantly higher margin as compared to instrument sales, growth of this business as a percentage of total revenue means margins will expand. Services accounted for $199k (16%) of the total $1.2 million in sales in 2013 and $505k (29%) of the total $1.8 million in sales in 2014. We continue to expect to see services revenue grow on both an absolute basis as well as a percentage of total sales.

For 2014 Protea recorded $1.8 million in revenue, up 45% from 2013 but slightly below our $1.9 million estimate. Revenue was comprised of (and compared to in 2013) $743k in LAESI-related sales (+14% from $652k) with both periods consisting of five unit sales, $505k from Molecular Information Services (+154% from $199k), $76k from Research Products (+7% from $373k) and $120k from Grants (+100% from $0).

2014 COGS and operating expenses aggregated to $12.5 million (compared to our $12.7 million estimate), an increase from $11.5 million from 2013 which is mostly related to additional headcount and services expense related to the build-out of the company's Molecular Information Services business.

Net income and EPS, excluding non-operating items (change in derivative value, loss on asset disposal and gain on sale of subsidiary) were $11.4 million and ($0.17), in-line with our $11.4 million and ($0.17) estimates and compared to $11.1 million loss and ($0.25) in 2013.

The non-cash gain on sale of subsidiary ($1.3 million) recognized on the income statement in Q4 relates to the previously announced (yet not consummated until December) sale of PRGB's Proteabio Europe subsidiary to AzurRx BioPharma. PRGB generated gross proceeds from the sale of $587k. They also eliminate R&D expenses related to Proteabio Europe (which was ~$1.1 million in 2014) and now have a 33% equity interest in AzurRx.

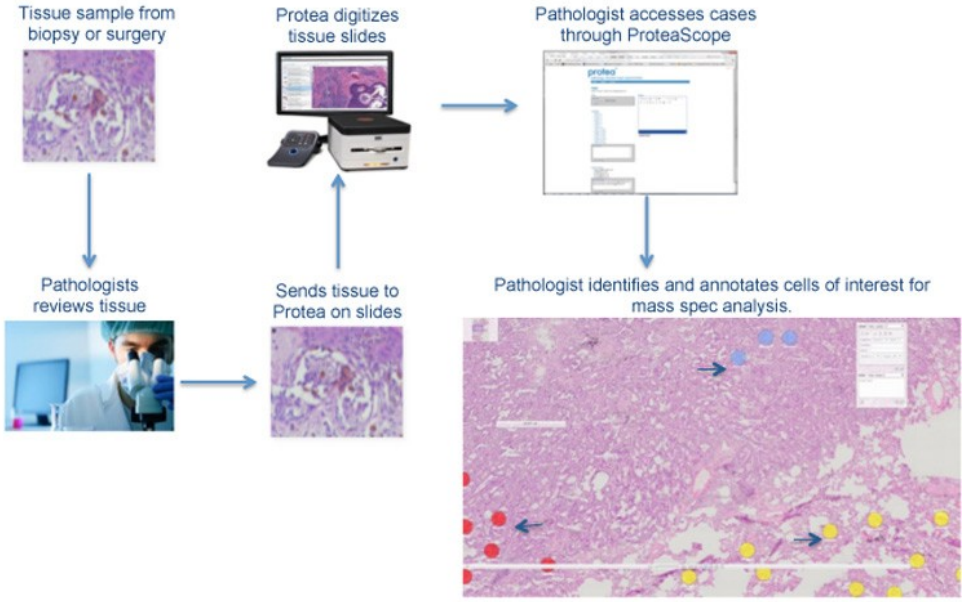
Cash used in operating activities was $7.3 million in 2014. Protea exited the quarter with $323k in cash and equivalents. They estimate that they will need ~$8.55 million in additional capital (in addition to cash from operations) to maintain operations through the end of the current year.

We have updated our model following the 10-K filing. We are maintaining our Outperform rating.

Protea Launches New Analytics Platform

During a presentation at Biotech Showcase, a premier annual life sciences conference held in San Francisco each January, Protea Biosciences announced the launch of its newest analytics platform. Dubbed, Histology Guided Mass Spec Imaging (HG-MSI), the service combines traditional optical microscopy with mass spec imaging. This allows pathologists to obtain mass spec chemical information from very precise regions within a sample. This precise targeting provides pathologists and researchers the ability to acquire chemical information from sub-populations of cells, offering potentially significant additional chemical information about the larger sample.

The HG-MSI process involves a pathologist reviewing a stained sample which are then then sent to Protea where they are digitized. The pathologist then accesses the digitized slides through Protea's proprietary ProteaScope web portal. ProteaScope involves the use of a histology-based ultra-high powered microscope to pinpoint very minute morphological areas of interest - once identified, mass spec data can then be obtained from these areas with the use of LAESI or MALDI mass spec.



SOURCE: Protea Biosciences.

We think HG-MSI, which has already been used in Protea's collaboration with Memorial Sloan Kettering Cancer Center for profiling of cell sub-populations in lung cancer tissue, may have significant utility in biomarker discovery for oncology, as well as other areas.

As we have noted in our ongoing coverage of Protea, we view their services-related business as an area of particularly high growth potential. Protea's molecular information services offerings is perhaps unmatched in the scope and depth of capabilities related to direct molecular imaging and related analytics. It is the only lab in the world that offers the complementary platforms of LAESI and MALDI under one roof. In addition, mass spectrometry imaging is quickly gaining interest for various applications but requires expensive equipment and highly trained personnel to perform it and analyze the results. As such, MSI is out of reach to most laboratories and research institutions, which offers real opportunities for Protea. With state-of-the-art equipment including LAESI and MALDI mass spectrometers, proprietary MSI software including their ProteaPlot software, and highly trained personnel, Protea believes their molecular information services business has unmatched capabilities in mass spectrometry and MSI. This new HG-MSI workflow platform adds another unique and significant service to the company's offerings, expanding their capabilities, further separating themselves from the competition and offering another revenue opportunity.

Protea has already scored contract work from cancer research institutions related to biomarker discovery and global biopharmaceutical companies related to preclinical drug development. HG-MSI should also afford even greater interest in Protea's capabilities from other potential partners. The company has acquired 20+ unique customers since 2013. Protea envisions further contracts from biotechnology / pharmaceutical / universities / government agencies related projects such as biomarker discovery and preclinical drug trials (particularly in areas such as oncology and neurodegenerative diseases - difficult to diagnose diseases with large markets) which could eventually culminate in the development of commercialized products such as novel drugs or diagnostic assays.

SNAPSHOT

Headquartered in Morgantown, West Virginia, Protea Biosciences Group (PRGB) is a commercial stage molecular information company. The company's proprietary technology platform, molecular information services and molecular data and informatics products afford a more rapid and comprehensive analysis of biological samples as compared to traditional instruments and methods. Largely targeted to medical researchers (although also having applications in other areas including agriculture, biodefense and forensics) and offering certain benefits over legacy instruments, the company's technology affords the potential to facilitate significant advancements in fields such as pharmaceutical research and development and biomarker discovery.

At the forefront of Protea's proprietary offerings is their LAESI® (laser ablation electrospray ionization) technology platform for use with mass spectrometry. Mass spectrometry is used to identify molecules and chemicals based on their mass to charge ratio. Mass spectrometry is estimated to be about a $4 billion market globally[1] with medical research applications accounting for the major share of the market.

LAESI affords certain significant benefits over traditional mass spectrometry, most notable of which is that LAESI enables direct molecular imaging in 2 and 3 dimensions. Direct molecular imaging via LAESI allows researchers to display the presence, relative quantitation and location of over 1,000 distinct molecules in a single analysis. Also, LAESI analysis occurs in an ambient environment (as opposed to in a vacuum) allowing for the direct analysis and imaging of biological samples such as cell and bacterial colonies. Finally, LAESI eliminates the need to destroy a sample or perform sample preparation which is a requirement of traditional mass spectrometry.

These advantages not only significantly increase throughput (e.g. the time for sample preparation for MALDI can be up to ~24 hours), they also greatly reduce the risk of sample contamination, skewed and unreproducible results, and destruction of the sample, all of which can occur with other ionization methods. And since the integrity of the sample is maintained, this allows for the analysis of live cells and the ability to track molecular changes in the cells over time, something that is unique only to LAESI. These benefits of LAESI (which also includes being less costly as a result of no sample preparation) are expected to be particularly attractive to pharmaceutical and biotechnology companies, which spend upwards of $20B/year on drug development and biomarker discovery and increasingly demand higher sensitivity, reproducible results and increased capabilities of biomolecular imaging.

Protea is the exclusive licensee of the LAESI technology from George Washington University, where the technology was developed. LAESI has been a recent recipient of industry awards acknowledging it as one of the best new technologies and laboratory products.

Commercialization of LAESI is still very much at the early stages. In March 2012 Protea entered a non-exclusive co-marketing agreement with Waters Corp., one of the largest mass spectrometer manufacturers. Through the end of 2014 they have sold ten units but expect the placement curve to steepen, facilitated by greater awareness of the technology particularly in areas of medical research and the recent hiring of key sales and marketing personnel. The OEM mass spectrometer market is highly consolidated and fiercely competitive with market share gains often a result of the introduction of new and better performing instruments. We expect this to benefit Protea and sales of their LAESI DP-1000 instrument as the LAESI technology appears to not only improve instrument performance but also expands the menu of applications the instruments are appropriate for. Protea will look to partner with other mass spectrometer manufacturers (similar to the arrangement with Waters) which would greatly expand their potential footprint.

Protea also offers molecular information services which leverages LAESI, the company's highly-trained laboratory personnel, state of the art mass spectrometry equipment and instruments to support mass spectrometry imaging and is aimed primarily at the pharmaceutical and biotech industries for applications in areas such as preclinical drug development and biomarker discovery. Protea's services business is largely focused on identifying and characterizing molecules associated with diseases to elucidate the underlying causes, mechanisms and drivers with the goal of identifying new treatments for these diseases. However, similar to the potential for the DP-1000 instrument, the services business is relevant to other industries besides

[1] *Global Spectrometry Market (Atomic, Molecular and Mass Spectrometry)-Scenario, Trends, Industry Analysis, Size, Share & Forecast 2011 - 2017.* Transparency Market Research

just life sciences and is already generating interest in a variety of areas including medical research, as well as agricultural and industrial applications.

The broad range of laboratory services, highlighted by LAESI (and complemented by other imaging and analytical capabilities), has already drawn substantial interest from the medical field. In 2014 the company secured a biomarker discovery project with a cancer research institute and contracts with four “top 20” pharmaceutical companies bringing its total number of customers to over 20. The company is actively involved in promoting the capabilities of its services business, which has not only resulted in initial contract wins but also increased awareness of LAESI and culminated in the consummation of research partnerships. The expectation is that early successes with these initial contracts will further build awareness, particularly among research departments of life sciences companies, of the capabilities of the company's imaging and molecular information laboratory and the benefits that their next-generation technology provides in areas such as biomarker discovery and drug development.

Protea is also developing molecular data and informatics products through collaborations with leading medical research institutions and internal efforts. In April 2014 Protea announced that it entered into a collaboration with Memorial Sloan Kettering Cancer Center (MSKCC) and Dana-Farber Cancer Institute to study lung adenocarcinoma samples with LAESI. In May 2014 the company announced that it entered into a collaboration with the University of Southampton to study Alzheimer’s brain samples with LAESI. As part of these collaborations Protea has the right of first refusal for the intellectual property that may result from these collaborations, which the company would seek to develop, license or find a partner for.

The company continues to aggressively seek out additional partnering opportunities that will leverage their expertise and unique advantages of their LAESI platform - in early July 2014 the company announced a collaboration with InSphero AG, the leading supplier of 3D organotypic microtissues, whereby the companies will use LAESI (and its 3D capability) and InSphero’s proprietary 3D microtissues to create 3D molecular profiles for research applications, including for drug discovery. The duo expects to generate new products and services from the partnership which will then be co-marketed to medical researchers, including InSphero’s current customer base which includes the top ten pharma and cosmetic companies.

Protea operates its laboratory and administration out of two facilities which aggregate to approximately 20k square feet and are located in Morgantown, W.V. The company is lead by a management team with significant experience in mass spectrometry, advanced imaging, assay development and business development of life sciences companies. The management team has deep ties to the mass spectrometry industry and includes those which had high level positions at some of the largest mass spec manufacturers in the world. We think this not only provides credibility to Protea's technology and service-based capabilities but also likely provides a Rolodex of key industry contacts which should aid the sales efforts.

The initial roll-out of LAESI as well as the company's services-related business are still in their infancy. And while we believe the benefits and competitive advantages of the technology and the unmatched scope, depth and expertise of the services business has the potential to attract significant demand (primarily for medical research) and eventually push the company to profitability, there are substantial near-term risks. These include that the company has generated relatively insignificant revenue to-date, has a cash-burn rate that is averaging approximately $1.6 million per quarter, has a substantial amount of debt (including almost $6 million listed as current debt) and only a minimal amount of cash as of the most recent reporting period (12/31/2014).

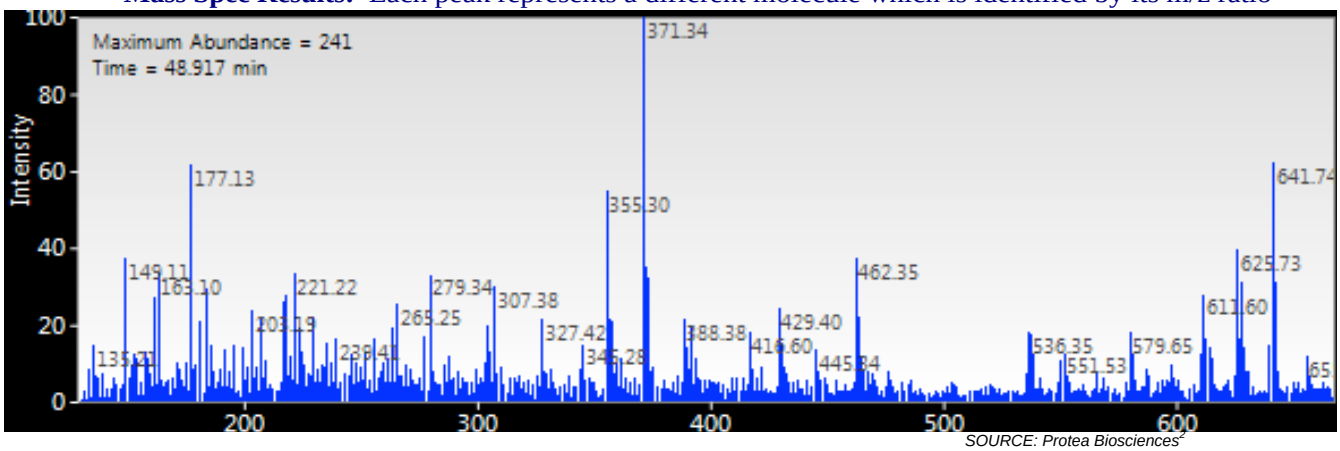
BACKGROUND

Mass Spectrometry

Mass spectrometry is the identification of molecules or chemicals based on their mass - with each molecule having a unique mass. Mass spectrometry works by first ionizing the particles which converts it to a gas-phase ion and gives them a charge - when charged they can then be separated and identified by the spectra of the masses of the molecules - this is measured by a mass-to-charge ratio (m/z). There are several ionization methods, which we discuss more below.

Following ionization, the ionized sample travels via electrical and magnetic fields into the analyzer of the instrument and into the detector which measures the amount of each ion type - and identifies each molecule based on its m/z ratio.

Mass Spec Results: Each peak represents a different molecule which is identified by its m/z ratio



SOURCE: Protea Biosciences[2]

Ionization

There are several types of ionization methods available, the use of which can be determined by the type of sample that is to be analyzed as well as the mass spectrometer being used. The two general classes of ionization are electron ionization and chemical ionization. Electron ionization (EI) is called a "hard" ionization technique in that the electrons interacting with the sample produce high quantities of residual energy and breaks bonds of the molecule, producing a high degree of fragmentation. This high fragmentation produces a highly detailed mass spectra allowing for predictable and reproducible identification of the molecule.

Chemical ionization (CI) is a "soft" ionization technique in that it imparts little residual energy and results in very little fragmentation but also with a simpler spectrum. CI is typically used for molecules that fragment excessively. CI involves the use of a reagent gas.

The most commonly used ionization technique, particularly for life sciences applications, is called matrix-assisted laser desorption/ionization (MALDI), which is soft ionization technique (which is estimated to hold ~70% market share). Other popular ionization methods include direct analysis in real time (DART), desorption electrospray ionization (DESI) and Protea's ionization technology, called laser ablation electrospray ionization (LAESI). We contain most of our discussion to MALDI as an alternate ion source to LAESI as the other ionization techniques are less widely used for medical research applications such as biomarker discovery and drug development.

MALDI is a soft ionization technique. It requires sample preparation which involves adding a matrix solution which is easily absorbed by ultraviolet light. The matrix prevents decomposition of the sample and enables the transfer of laser light into heat. An ultraviolet laser is then fired at the matrix and is released into the sample as heat. The sample then desorbs and forms singly charged ions.

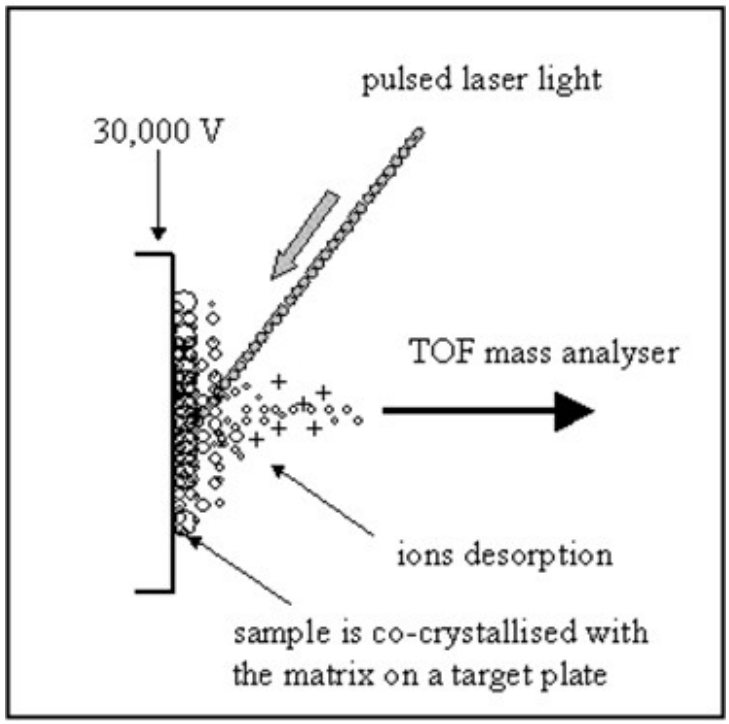
While MALDI has advantages of many of the other ionization techniques including high sensitivity and that it provides relatively excellent coverage for large molecules (such as proteins), it does have drawbacks. Some of these are that there is risk of matrix interference (i.e. skewed results) in the low molecular weight range and that since it uses a vacuum, it precludes testing of live specimens. And with all ionization techniques that use sample preparation, throughput is cumbersome and reproducibility can sometimes be an issue. Relative to throughput, sample preparation is time-consuming (~90 minutes) and the sample must remain in the matrix for an extended period (~24 hours) prior to analysis, which can be hindrances to productivity (particularly relative to LAESI where sample prep is not required). Relative to reproducibility, application of the matrix can be a fairly complex and difficult process and require the use of several different substances in specific amounts. While trained technicians are tasked with sample preparation, it is not always consistent and inconsistent sample preparation can result in inconsistent (i.e. not reproducible) mass spectrometry results. Reproducibility can be crucial, particularly during clinical trials used to support regulatory approval. Another potential drawback is when MALDI is used for mass spectrometry imaging (which we detail further below) is that the matrix can cause molecules of interest to migrate within the ion map, potentially causing accuracy issues relative to the spatial

[2] Unless cited otherwise, all charts, graphs, images, pictures, drawings and graphics are sourced from Protea Biosciences' electronic documents

arrangement of the molecules within the map. And finally, while MALDI has relatively very strong coverage of larger molecules, it has shortcomings with smaller molecules (which we also detail further below).

MALDI is often combined with Time of Flight (TOF) mass spectrometers (MALDI-TOF). TOF analyzers are considered the fastest of all mass spectrometers and are most commonly used in medical research and clinical applications.

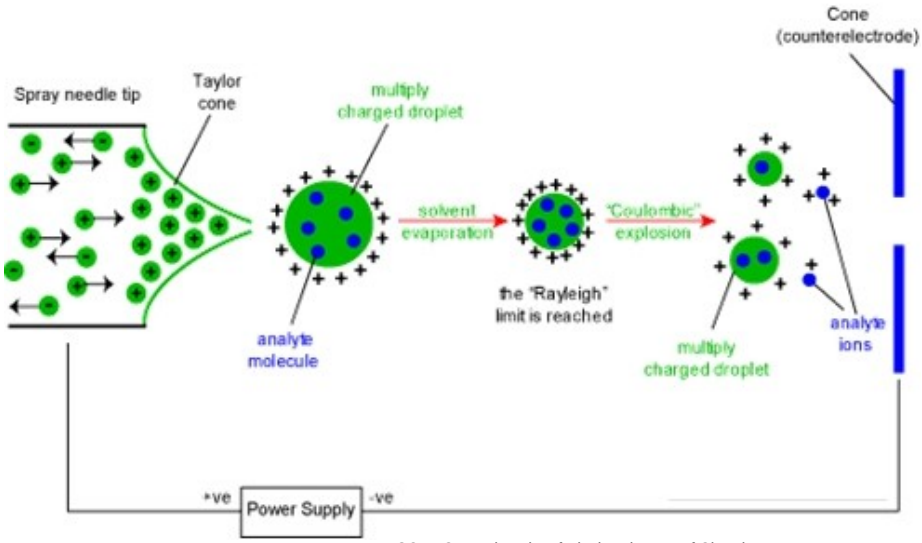
MALDI



SOURCE: University of Pittsburgh Dept of Chemistry

Typical ESI (electrospray ionization) also involves some sample preparation and requires the sample to be dissolved in a solvent. This liquid is then dispersed by electrospray into an aerosol, the droplets which shed ions which are then sent into the mass spectrometer via a vacuum. DESI is a combination of ESI and desorption. It involves directing an electrically charged mist (typically a combination of methanol and water) to the sample which produces ionization. Voltage is applied to the sample base which attracts the electrospray. The ions then travel through to the mass spectrometer. Unlike ESI, DESI can be accomplished at atmospheric pressure (as opposed to in a vacuum) and also requires little sample preparation. Both ESI and DESI are soft ionization techniques. The advantages of ESI and DESI are that they produce multiply charged ions, allowing for analysis of greater range of masses. The disadvantages include sample preparation (ESI), the samples must be soluble and only limited structural information can be obtained due to the simple mass spectrum produced.

ESI



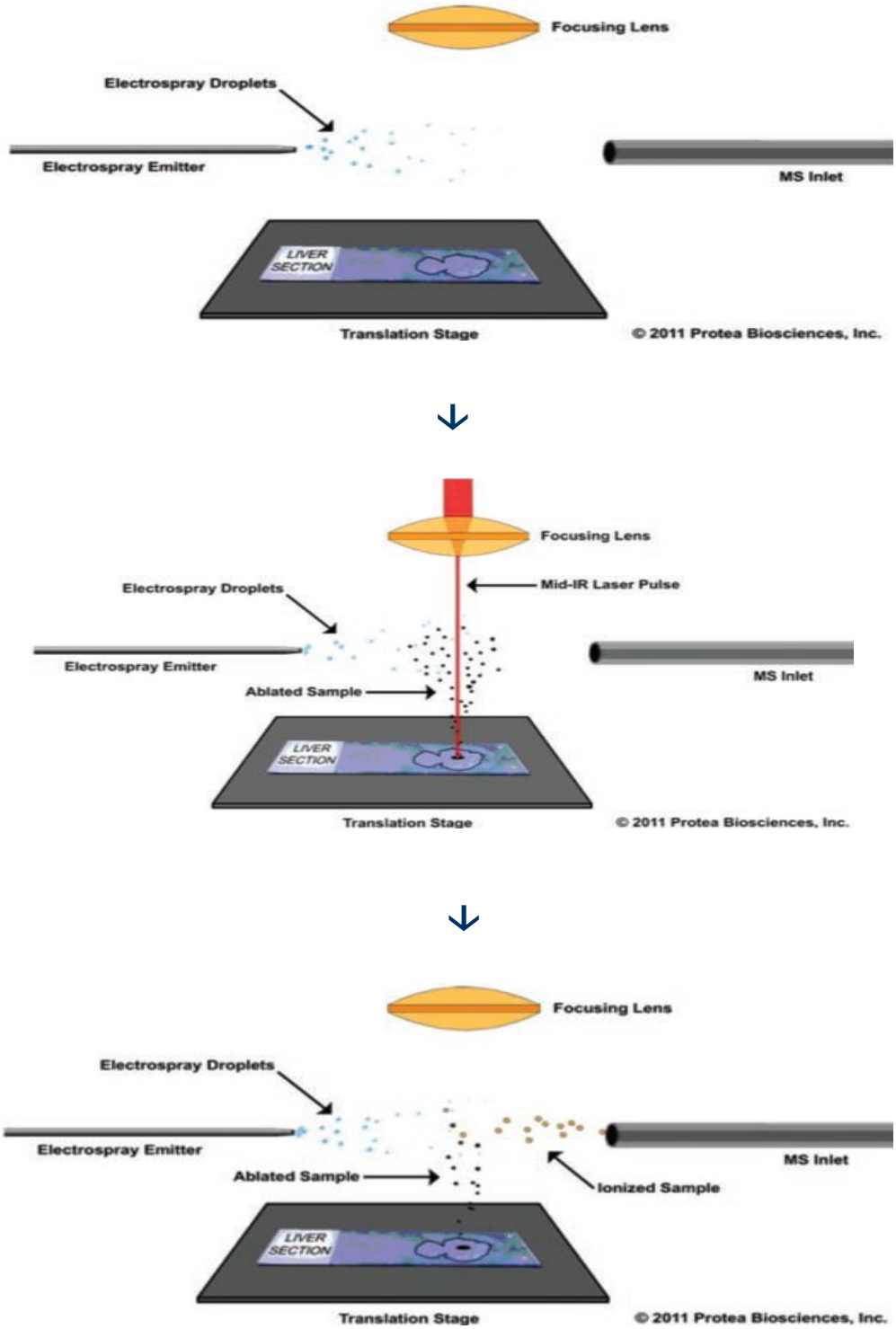
SOURCE: University of Pittsburgh Dept of Chemistry

DART is another ambient pressure and soft ionization technique. Ionization occurs directly on the sample surface and no sample preparation is required. DART involves holding the sample to be analyzed between the DART ion source and the mass spectrometer. The relative advantages of DART are that no sample preparation is required, sample analysis can be done rapidly and relatively large objects can be examined. The drawbacks of DART include that it produces a relatively simple spectrum, multiply charges ions are not produced, and lower sensitivity.

Laser Ablated Electrospray Ionization

LAESI is a soft ionization technique with no sample preparation required and can be done under ambient conditions. It can be used with any sample that contains water. It uses a mid-infrared laser, the wavelength of which corresponds to the absorption line of water. The laser is fired at the sample, is absorbed by the water and creates a gas plume. The gas particles are then ionized with an electrospray ionization plume and finally analyzed by the mass spectrometer.

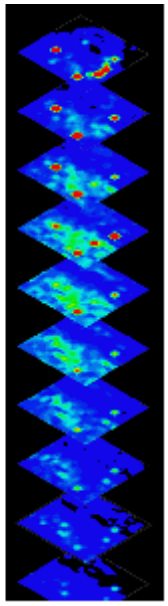
LAESI Process



LAESI provides for certain advantages over other ionization methods. No sample preparation and accomplished in ambient conditions means faster throughput, no risk of matrix interference and the ability to analyze live cells as well as to track molecular changes in the cells over time. LAESI, which uses a mid-IR laser that does not destroy the sample, also has the ability to tunnel through sections of the sample and capture data as it does. This affords the ability to produce three dimensional images, something that is not possible with other ion sources.

LAESI 3D Imaging

Unique to LAESI is that it also allows 3D mass spectrometry imaging - the image shows ion maps of mass spec data ten layers deep in a leaf (the red spots being presence of a herbicide, the chemical of interest in this experiment). 3D imaging is a clear advantage of LAESI and one which is expected to have particular utility in applications such as oncology, where it can provide biomolecular information throughout the depth of the tumor without having to continuously cross-section it.



Protea has already scored research work related to the ability to capture 3-D images and expects this to have particular utility in applications such as oncology where it can provide biomolecular information throughout the depth of the tumor without having to continuously cross-section it. Three dimensional imaging and the ability to track changes to cells over time is also likely to garner meaningful interest from pharmaceutical and biotech companies interested in observing how an investigational drug effects changes to cell metabolism.

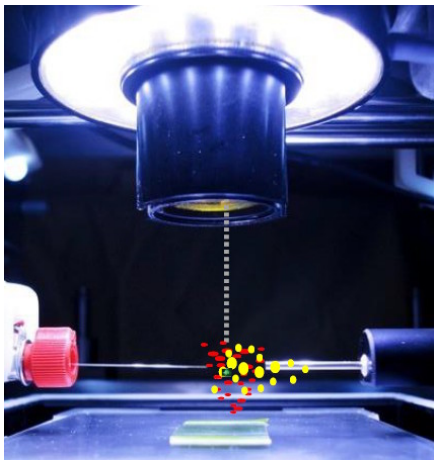
Specific to the opportunity to leverage the 3D capability of LAESI, in early July 2014 the company announced a collaboration with InSphero AG, the leading supplier of 3D organotypic microtissues, whereby the companies will use LAESI (and its 3D capability) and InSphero's proprietary 3D microtissues to create 3D molecular profiles for research applications, including for drug discovery. The duo expects to generate new products and services from the partnership which will then be co-marketed to medical researchers, including InSphero's current customer base which includes the top ten pharma and cosmetic companies. Given InSpero's leading position in 3D microtissues, we see this collaboration as validation of the utility of high-performance 3D imaging in medical research and drug discover and the related capabilities of Protea and LAESI in this space.

LAESI also only consumes (via ablation) a very small portion of the sample, allowing for additional future analysis. LAESI can be used with biomolecules of all sizes, from macromolecules such as proteins and lipids to small molecules such as metabolites. It can also be used for a wide range of sample types including solids, liquids, tissues, cells and biofluids. Similar to ESI and DESI, LAESI produces multiply charged ions, allowing for analysis of large biomolecules.

LAESI DP-1000

The LAESI technology was developed at The George Washington University in Washington, D.C. and since 2008 has been exclusively licensed to Protea. Protea completed development of their LAESI DP-1000 instrument in 2011. The instrument combines ionization and a high resolution camera to provide quantitative and qualitative data for two and three dimensional workflows.





LAESI DP-1000, when combined with a mass spectrometer, allows for the mass spectrometer data to be combined with actual images of the tissue and cell samples - which affords the benefit of being able to evaluate the mass spectrometry data in the context of the biology of the sample. The ability to do this with live cells and bacterial colonies is unique to other ionization techniques and is potentially hugely advantageous to researchers interested in seeing and tracking changes to cells over time or when introduced to a particular compound such as an investigational drug.

LAESI DP-1000 integrates with various mass spectrometers including time-of-flight (TOF) instruments. In early 2012 Protea commercially launched LAESI DP-1000 and entered into a co-marketing agreement with Waters Corp, one of the largest mass spectrometry manufacturers and with instruments that are compatible with DP-1000. Under the agreement Waters has non-exclusive rights to market LAESI DP-1000.

Side View of DP-1000 Coupled to Waters Mass Spectrometer



LAESI is also compatible with mass spectrometers from Thermo Fisher. The mass spectrometers from Waters and Thermo Fisher that LAESI is compatible with account for approximately 50% of the total share of the mass spectrometry market. We also expect that Protea will look to add adapter kits for use with mass spectrometers of other manufactures, including the likes of AB Sciex and Agilent, which would further expand the potential market for LAESI.

LAESI DP-1000 Recognized As A Significant New Technology…

Even before the commercial launch, Protea and LAESI DP-1000 were recognized by the scientific community for technological innovation. In January 2012 LAESI DP-1000 was recognized as a Top Ten Innovation of 2011 by The Scientist Magazine.

Around the same time of the commercial launch, Protea was presented with the 2012 Pittcon Editor's Bronze Award, naming the DP-1000 instrument as one of the best new products at the 2012 International Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy. Pittcon is considered the world's largest annual conference for laboratory science.

Just a few months of receiving the Pittcon award, the DP-1000 instrument received a 2012 R&D Award presented by R&D Magazine. The award named LAESI DP-1000 as one of the 100 most technologically significant products introduced during the year. The R&D 100 Awards have been presented since the 1960's and have identified technologies that have become commonplace since their introduction including the ATM machine, fax machine, LCD displays and HDTV, among several others.

Then in July 2012 Frost & Sullivan recognized Protea with the 2012 North American Award for New Product Innovation in Bioanalytics for the LAESI DP-1000. In recognizing Protea for the award, Frost & Sullivan's Senior Industry Analyst, Christi Bird, noted, "The LAESI DP-1000 system greatly improves the efficiency of biological investigations, allowing scientists to better understand the mechanics of pathology and the effects of drug and target interaction."



In addition to the industry awards recognizing LAESI as an important emerging technology, Protea notes that there are more than 35 peer-reviewed publications describing the use of LAESI in various experiments, several of which included the analysis of live cells. Protea has an archive of some of these published documents and case studies on their website.

Commercialization Underway…
Official launch of LAESI DP-1000 happened in early 2012 with consummation of the co-marketing agreement with Waters although a substantial sales effort did not happen until later that year. The first LAESI DP-1000 instrument was sold in March 2013 and through the end of 2014 ten units have been sold.

Marketing activities largely focus on attendance and presentation at various industry exhibitions. Both Protea and Waters participate in exhibitions - Protea noted that in 2013 they attended over 10 industry exhibitions. Waters has also been active in promoting the instrument at major industry conferences including the global 2013 American Society for Mass Spectrometry (ASMS) annual conference and the upcoming 2014 ASMS conference.

As the agreement with Waters is non-exclusive, Protea has the option to partner with other mass spectrometry manufacturers and/or distributors. They may also build out their own internal sales force. As the instrument is ideally suited for medical research and drug discovery purposes, this is a target market that Protea is likely to focus towards. The extensive, and growing, list of peer-reviewed published manuscripts and experiments, a substantial portion of which included the analysis of live cells and bacterial colonies, will likely help facilitate the sales effort and interest in LAESI from the scientific and medical communities.

Molecular Information Services
In addition to the LAESI DP-1000 instrument, Protea also has proprietary molecular information services that leverage LAESI and the Company's scientific expertise. Protea offers mass spectrometry imaging (using LAESI as well as MALDI platforms) and bioanalytical services. MALDI, which provides higher coverage of large molecules (such as proteins), is a perfect complement to LAESI which, while strong throughout the mass spectrum range, has better coverage of smaller molecules. Protea believes its molecular information services offer a combination of experience and state-of-the art mass spectrometry imaging equipment that is unsurpassed by any other commercial lab.

The services business is aimed primarily at the pharmaceutical and biotech industries for applications in areas such as preclinical drug development and biomarker discovery. It is largely focused on identifying and characterizing molecules associated with diseases to elucidate the underlying causes, mechanisms and drivers with the goal of identifying new treatments for these diseases - the initial focus is oncology and neurodegenerative diseases.

The broad range of laboratory services, highlighted by LAESI (and complemented by other imaging and analytical capabilities), has already drawn substantial interest from the medical field. In 2014 the company secured a biomarker discovery project with a cancer research institute and contracts with four "top 20" pharmaceutical companies bringing its total number of customers to over 20. The company is actively involved in promoting the capabilities of its services business through a direct sales force of five sales and marketing professionals, which has not only resulted in initial contract wins but also increased awareness of LAESI and culminated in the consummation of research partnerships. The expectation is that early successes with these initial contracts will further build awareness, particularly among research departments of life sciences companies, of the capabilities of the company's imaging and bioanalytical laboratory and the benefits that their next-generation technology provides in areas such as biomarker discovery and preclinical drug development, markets estimated at approximately $18 billion and $13 billion, respectively.

Protea's **mass spectrometry imaging** (MSI) services allow the ability view the spatial distribution of molecules within the sample slice. In MSI, the mass spectrum of the entire sample is recorded and each molecule (or spectral peak as it represented graphically) is defined by a specific color - with potentially thousands of molecules being represented in a given sample. These colors are then overlaid on a map of the sample (called an ion map), allowing researchers to see the spatial distribution of the molecules within the sample. MSI is still very much in its infancy but is quickly gaining interest in for various applications including for viewing how a drug metabolizes throughout the body and in applications such as preclinical drug discovery. But while there is growing interest in MSI given its potential significant utility in advancing research in a wide range of industries including medical, industrial and agriculture, headwinds such as that it requires expensive equipment and highly trained (often PhD's) personnel to perform it, MSI is out of reach to most laboratories. This offers Protea's lab services business a real opportunity given that it is the only laboratory that provides contracted mass spec and MSI services. With state-of-the-art equipment including LAESI and MALDI mass spectrometers, proprietary MSI software including their ProteaPlot software, and highly trained personnel, Protea believes their lab services business has unmatched capabilities in mass spectrometry and MSI.

Creating An Ion Map for MSI

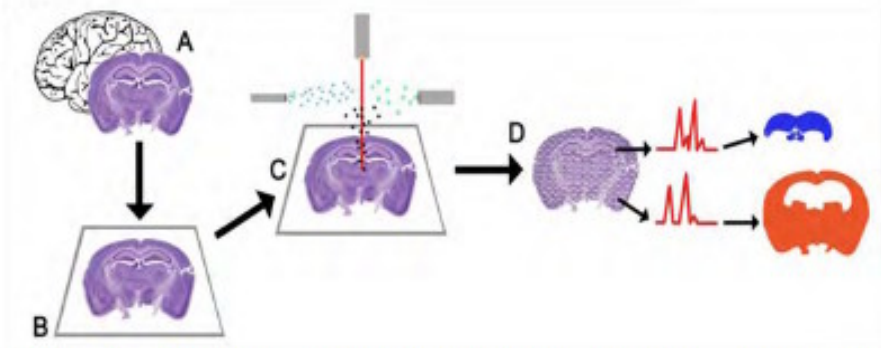


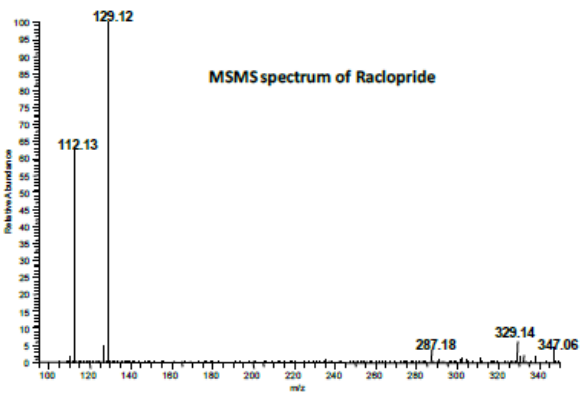
Figure 1: LAESI-MS workflow for tissue imaging. The tissue is cryosectioned (A), mounted on a glass slide (B), and subjected to LAESI-MS analysis (C). Data analysis (D) involves extraction of spectral information from each pixel to construct ion maps of the tissue.

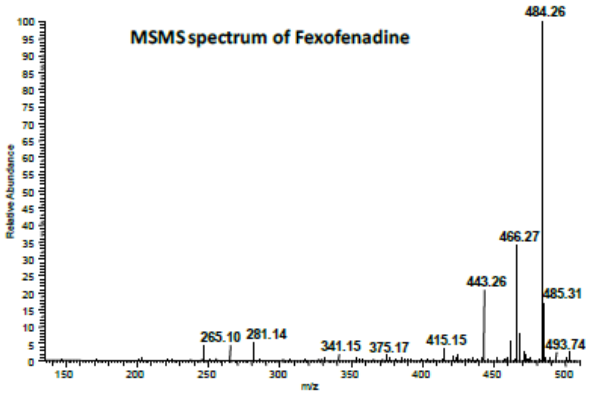
CASE STUDY: Using LAESI-MSI for Drug Targeting in Whole Mouse Body Sections

Protea performed MSI using its LAESI DP-1000 instrument for targeted drug localization (i.e. - to visualize where and how the drug distributed throughout the body) in whole mouse body sections. This provides a good explanation of MSI and representation of the potential utility that LAESI-MSI may have in applications such as determining how (and where) a novel drug metabolizes in the body.

In the study titled, *Molecular Imaging of Animal and Human Tissue Samples by LAESI-MS*, a mouse was dosed intravenously with raclopride (a common tracer used in PET procedures) and fexofenadine (generic name for Allegra), euthanized 30 minutes later, snap (i.e. - rapidly) frozen and then cryosectioned. A reference section of the abdomen was stained to visualize the anatomical regions. LAESI DP-1000 and a Thermo Scientific mass spectrometer were used. Protea's ProteaPlot software was used for data acquisition and imaging. Goal of the study was to view where the drugs migrated to in the mouse.

Below is the spectrum data generated by the mass spectrometer with the 129 m/z fragment peak representing raclopride and the 484 m/z fragment peak representing fexofenadine. These peaks will be represented by colors in the ion map.

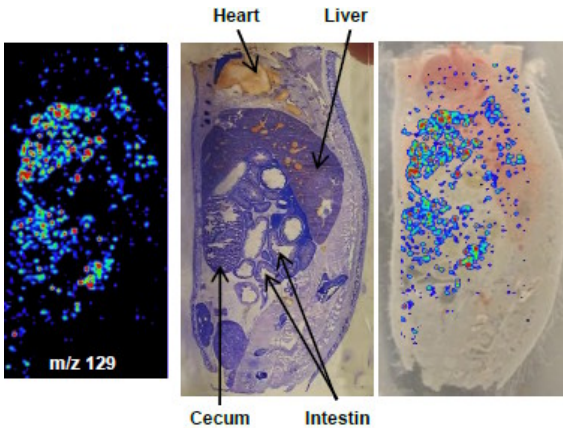




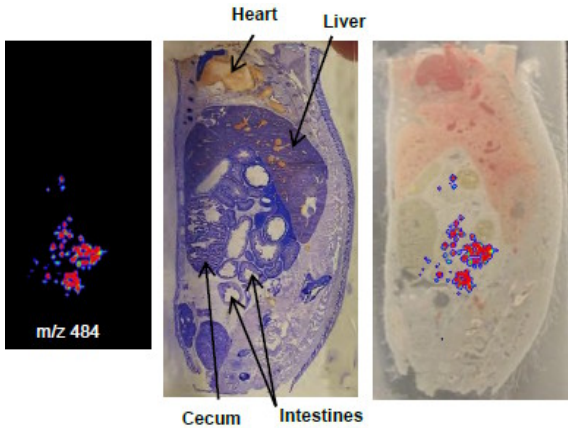
The images below show how the spectrum data from above is represented visually with mass spectrometry imaging. On the left of both groups of images is the ion map created from the spectrum data. The middle picture is a stained optical image of the tissue section which allows you to see the organs and anatomical structure of the mouse. On the right of both groups of pictures is an optical image of the tissue section with the ion map overlaid.

The blue dots are representative of raclopride and the red dots representative of fexofenadine. With MSI a researcher can see the spatial arrangement of molecules of interest. In this study, the researchers were able to see where the drugs were distributed within the mouse 30 minutes after dosing. Raclopride is detected in the intestines, cecum and liver. Fexofenadine is detected in the gastrointestinal organs.

Raclopride



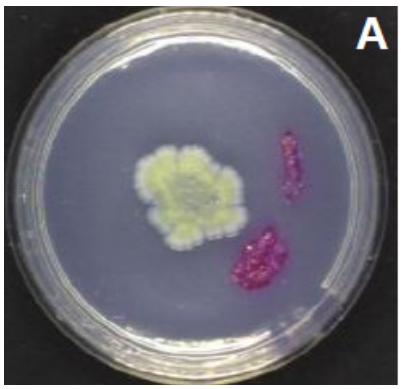
Fexofenadine

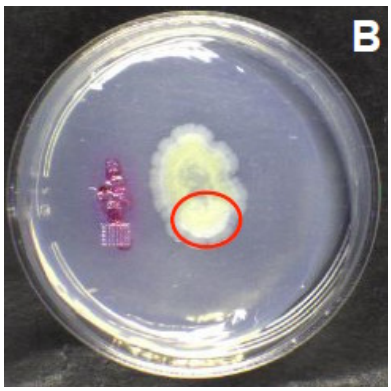


An experiment like this could have applicability in areas such as pre-clinical trials of novel drugs. As an example, a similar experiment using MSI with a novel drug may show that a high concentration of the drug is detected in the liver of the mouse, potentially indicating toxicity issues. As pharmaceutical and biotech companies spend upwards of $20 billion annually on drug discovery and only a small fraction of initial compounds eventually getting approval for commercial sale, they have an interest in identifying issues such as toxicity as early as possible. Protea believes LAESI-MSI and their services business will generate meaningful demand for such applications.

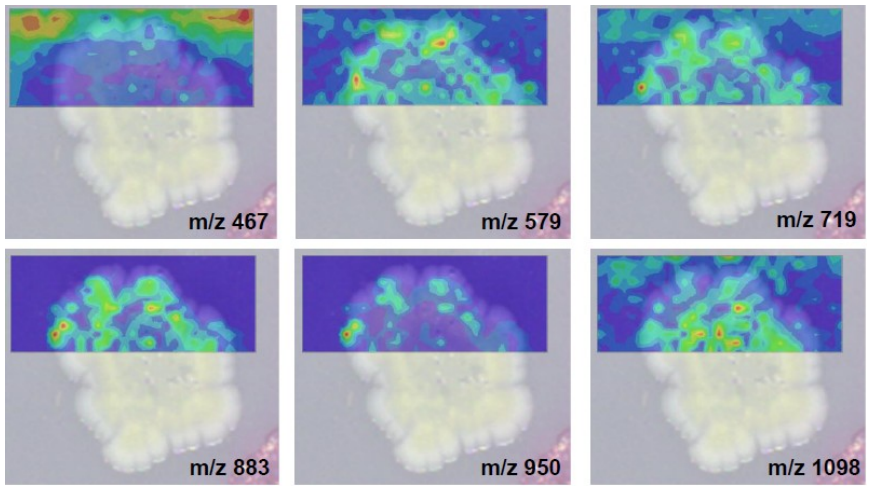
Analysis of Bacterial Colonies

In collaboration with the AMOLF Research Institute (Amsterdam, The Netherlands), Protea did an analysis of E. coli colonies using LAESI DP-1000. The experiment, titled *In vivo Analysis of Bacterial Colonies by LAESI-MS*, involved analyzing two sets of E. coli colonies which were grown in Petri dishes under different conditions. One was grown in a standard media solution (control group), the other was grown in the same media solution but with an antibiotic, amoxicillin-clavulanate, applied to a portion (red circle) of the colony. The experiment's goals were to show that LAESI DP-1000 was able to identify biomolecules of E. coli of certain m/z as well as showing the lack of E. coli in the antibiotic-treated region.

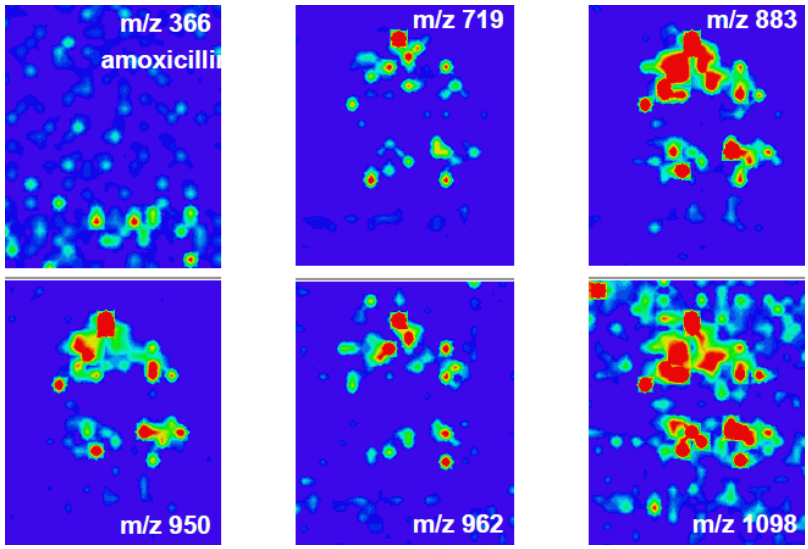




The images below are from the control group (i.e. - no antibiotic) and are ion maps of molecules of the bacteria overlaid on an image of the colony. The different m/z corresponds to various molecules of the bacteria. The red dots are representative of the respective m/z ions of interest.



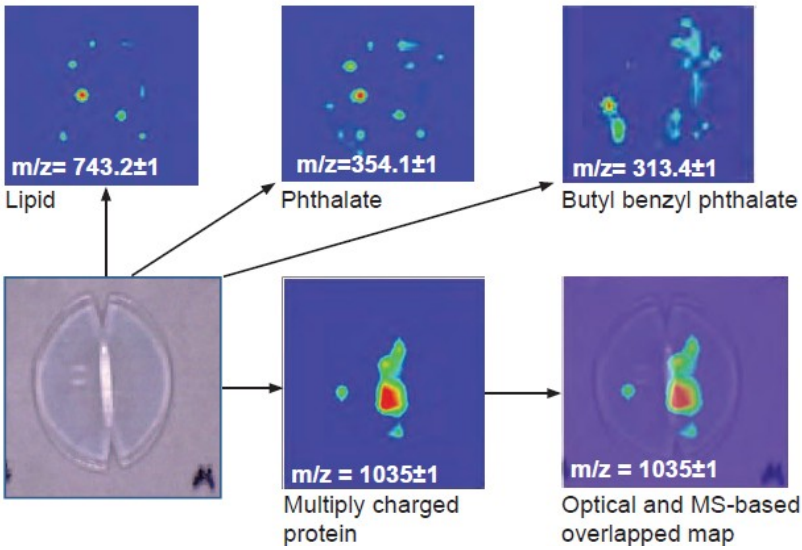
The next set of images, below, are from the antibiotic-treated colony (treated on the lower portion of the colony). The m/z 366 map corresponds to the antibiotic. The other ion maps correspond to bacterial molecules. Note that the amoxicillin-clavulanate is clearly visible in the m/z 366 slide. Also note that the bacterial molecules are not present in the lower portion (i.e. - the antibiotic-treated area) of the other slides.



LAESI-MS Imaging of Contact Lenses

Protea performed an experiment where they analyzed hydrogel contact lenses with LAESI DP-1000. Contact lenses have an inherent water content and are of a rather fragile material. If analyzed using an ionization technique such as MALDI, which would require the use of a matrix and dehydration, the sample would likely be compromised.

The images below are from the experiment. They show the identification of specific lipids and proteins that accumulate during normal wearing of the lenses. It also identified molecules of the components of the lens (phtalate, butyl benzyl phtalate).



These two experiments (bacterial colony and contact lens) could not have been done with vacuum ionization. They have real-world applicability and potential utility in the industrial and medical industries, among others. Relative to the bacterial colony experiment, this would be directly applicable to, for example, a biotech company investigating a novel antibiotic and the efficacy of the drug on the target bacteria.

Relative to the contact lens study, this has obvious utility in the development of contact lens cleaners and, potentially, in the development of longer-wear contact lenses that reduce the build-up of lipids and proteins.

There is also significant and growing interest in finding an analytical technique that can better identify harmful biofilms that can accumulate on medical devices. Both of these experiments provide insight into LAESI's potential opportunity in this area as well. An article titled, *Analytical Challenges of Microbial Biofilms on Medical Devices*[3], published in the journal, Analytical Chemistry, details the significant problem biofilms on medical devices. The authors note that 60%+ of the ~1.7 million healthcare associated infections in the U.S. every year are related to medical device associated infections, that these infections are typically associated with the colonization of devices by microbes (i.e. - biofilms) and the annual cost of healthcare associated infections is estimated at $28 - $45 billion. The authors explain the difficulty in detecting certain microorganisms and note that better analytical techniques are needed. Although the authors do not endorse a particular analytical method relative to improving the detection of biofilms, several are mentioned as potential options, including LAESI-MS.

MARKETS

Mass Spec To Exhibit Robust Growth, Particularly in Life Sciences Applications…

According to a comprehensive market research report on the mass spectrometry market published in October 2013 by Strategic Directions International, Inc. (SDI) titled, *Mass Spectrometry: Limitless Innovation in Analytical Science, 2012 - 2017*, the global market for all mass spectrometry instrumentation was worth approximately $4 billion in 2012 and is expected to grow at a CAGR of about 7% through 2017. Another

[3] *Analytical Challenges of Microbial Biofilms on Medical Devices*. Vertes V, Hitchins V, Phillips KS. Analytical Chemistry 2012,84,3858-3866

forecast, by Frost & Sullivan, which had a more narrow focus and looked at just the mass spectrometry and liquid chromatography-mass spectrometry market, pegged the global market at $1.7 billion in 2012 which they estimate to grow to $2.5 billion in 2017, implying a CAGR of 8%.[4]

SDI notes that almost 80% of demand for mass spectrometry currently comes from the U.S., Europe and Japan, although much of the growth geographically is expected to come from developing parts of the world including China and Latin America. Demand in developed nations is expected to grow in the mid-single digits over the next five years.

According to SDI, current demand is driven largely from the pharmaceutical and biotech industries which, along with clinical research organizations (CRO) account for just over 30% of the global mass spectrometry market. Interestingly, however, is that while the specific industry categories indicate 30% of demand is coming from the life sciences field (not including hospital/clinical), mass spectrometry use for medical research applications (regardless of the industry classification) may actually be closer to 50%. This ~50% figure is based on a survey by SDI which asked respondents to identify which type of application they used MS for, regardless of the industry setting. Whether it's 30% or 50%, it's clear that there is significant (and growing) demand for mass spectrometry in medical research related applications.

Figure VI-3: Overall Mass Spectrometry Demand by Industry, 2012

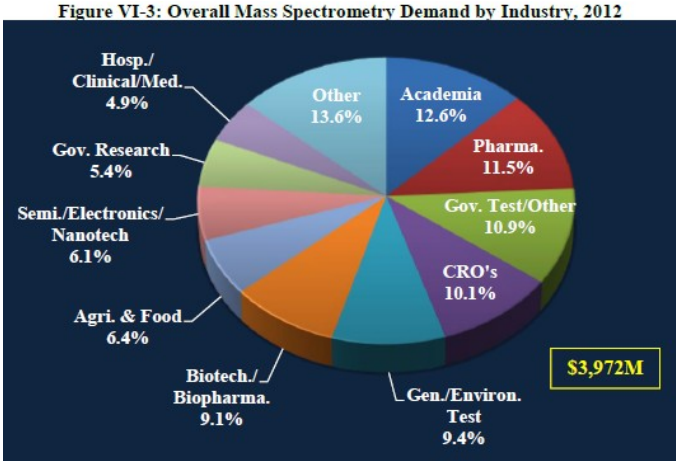
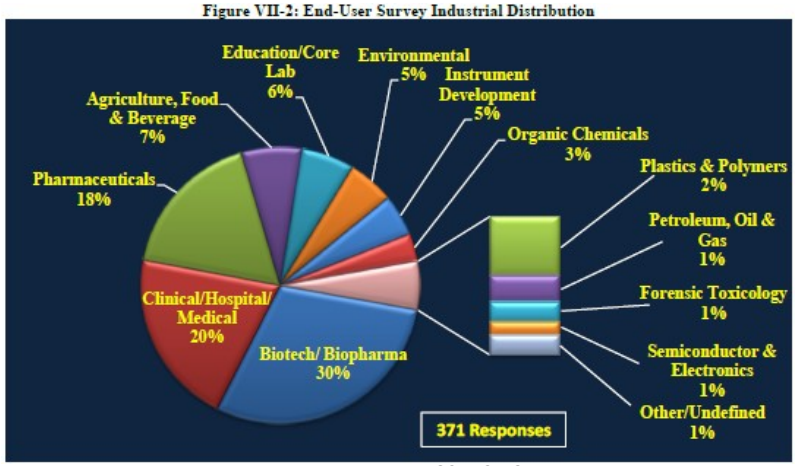


Figure VII-2: End-User Survey Industrial Distribution



SOURCE: SDI Inc.

The significant use of mass spectrometry in these industries is related to disease and drug research and drug manufacturing. Much of the growth domestically is expected to come from medical applications including burgeoning demand for mass spectrometry in clinical diagnostics, which SDI points to as the one specific area that mass spectrometry will see the greatest increase in demand from as mass spectrometry finally begins to get over the regulatory hurdle for use in this setting. Demand growth from biotech, pharma and CRO's is expected to remain robust for the foreseeable future and be second only to that from clinical diagnostics applications.

Table VI-3: Overall Mass Spectrometry Forecast Demand by Industry (2012-2017, Millions of USD)

	2012		2013		2014		2017		'12-'17
	$ Mil	Percent	$ Mil	Percent	$ Mil	Percent	$ Mil	Percent	CGR
Academia	501.6	12.6%	505.2	12.3%	530.4	12.0%	672.6	12.1%	6.0%
Pharmaceuticals	457.7	11.5%	491.6	12.0%	534.0	12.1%	664.0	12.0%	7.7%
Government Testing/Other	432.1	10.9%	391.9	9.6%	412.7	9.4%	519.1	9.4%	3.7%
Contract Research Org. (CRO)	399.6	10.1%	432.9	10.6%	476.3	10.8%	619.5	11.2%	9.2%
General/Environ. Test Lab	374.8	9.4%	391.4	9.6%	416.5	9.4%	499.7	9.0%	5.9%
Biotech./Biopharma.	361.5	9.1%	392.3	9.6%	433.9	9.8%	568.6	10.3%	9.5%
Agriculture & Food	254.0	6.4%	271.1	6.6%	292.4	6.6%	359.1	6.5%	7.2%
Semi./Electronics/Nanotech	241.1	6.1%	228.7	5.6%	248.2	5.6%	297.7	5.4%	4.3%
Government Research	215.8	5.4%	215.2	5.3%	225.9	5.1%	285.5	5.2%	5.8%
Hospital/Clinical/Medical	193.1	4.9%	215.5	5.3%	243.3	5.5%	339.2	6.1%	11.9%
Chemicals	105.3	2.7%	108.9	2.7%	114.1	2.6%	130.2	2.4%	4.3%
Oil & Gas	95.5	2.4%	99.2	2.4%	105.3	2.4%	125.8	2.3%	5.7%
Other	340.2	8.6%	351.7	8.6%	376.4	8.5%	456.0	8.2%	6.0%
Total	**3,972**	**100%**	**4,096**	**100%**	**4,409**	**100%**	**5,537**	**100%**	**6.9%**

[4] *Mass Spectrometry Market to Touch $2.5B.* Frost&Sullivan. 26 November 2013.

SOURCE: SDI Inc

We see the dynamics of the mass spectrometry market as a tailwind for Protea, which has already garnered early interest in its LAESI technology and related services from organizations involved in medical research applications including the University of Oklahoma, Virginia Commonwealth University and a (currently unnamed) "top five" pharmaceutical company with which Protea recently entered a collaboration for a project related to biomarker discovery. The company has also noted that they are in active discussions with other potentially interested parties including other pharmaceutical companies.

And while Protea's major market focus is biotechnology and pharma for applications in areas such as biomarker discovery and preclinical drug research, their technology and lab services offerings have potentially significant appeal in other industries and applications. For example, the agriculture/food industry, a mass spectrometry market SDI estimates will grow from about $254 million in 2012 to $359 million in 2017 (7% CAGR), is a potentially ripe and low-hanging fruit opportunity for Protea. Along with applications such as development of novel and more environmentally-friendly herbicides, demand from the ag/food industry is expected to be at least in part driven from the introduction of stricter food safety testing requirements.

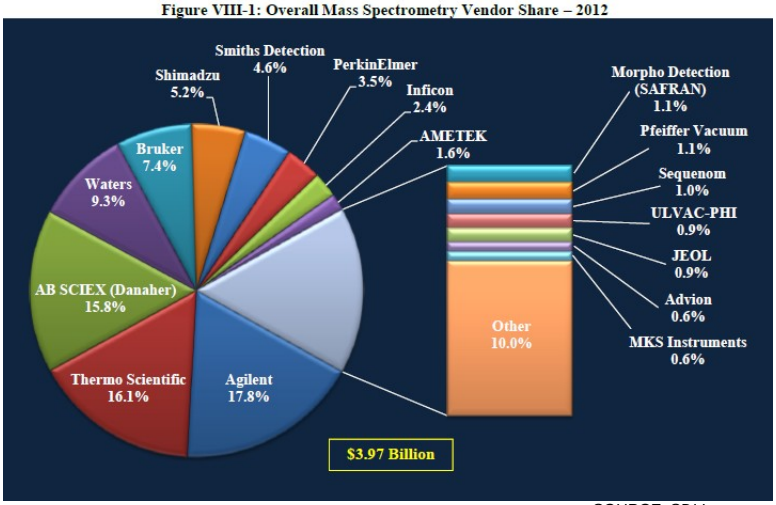
The U.S. Department of Agriculture recently bought a LAESI system which we view as particularly meaningful as this is the first major foray into the agricultural industry and which further validates the broadening scope of potential applications for the technology. The instrument will be used by the USDA for food-safety applications - specifically for the detection of mycotoxins (i.e. - molds). Again, LAESI's ability to analyze living cells was indicated as a critical functionality.

Other industries and applications that Protea could see demand from include forensic science, industrials and cosmetics, among others.

Mass Spec Market Highly Consolidated, Should Benefit Protea…

While there are a plethora of companies that manufacture or distribute various components, supplies and consumables related to mass spectrometry, there are only a handful of OEM mass spectrometry system manufacturers. Technological expertise, cost of development and manufacture of the instruments, and deep entrenchment by the already established players keep this a market which is difficult to enter. According to SDI, since 2009 the top six companies have increased their combined share of the market from less than 66% to 71% today.

Figure VIII-1: Overall Mass Spectrometry Vendor Share – 2012



SOURCE: SDI Inc

Despite the highly-consolidated nature of the mass spectrometry market, competition at the top remains fierce and market share has and does shift among the top six. Market share shifts are typically a result of either an acquisition of smaller firm which bolts on the additional percentage points or through the introduction of new and particularly competitive instruments. OEMs continue to look to innovation for improvement in areas such as instrument accuracy and sensitivity as well as cost and increased throughput. Other real competitive advantages lie in the ability to expand the utility and applications that the instruments are appropriate for. Given that these are relatively expensive instruments (up to $500k or more), a customer is likely attracted to the ability to use it for a bigger menu of applications.

This competitiveness is likely a benefit to Protea and their LAESI technology which looks to not only provide better images (particularly for smaller mass molecules) with significantly higher throughput and at a lower cost but also to provide utility for a variety of industries and applications. The LAESI technology has potentially broad utility across medical, industrial, food/agriculture and forensics, among others, which is unmatched among the other ionization methods. These are the types of attributes that can provide meaningful competitive advantages for not only the LAESI DP-1000 instrument as an ionization source, but for the OEMs as well.

Protea's commercialization strategy for its LAESI DP-1000 instrument involves entering into non-exclusive "co-marketing agreements" with the mass spectrometry OEMs (this is in addition to a direct sales effort). Protea is strategically structuring these agreements as not only non-exclusive but as non-distributor oriented as well. Instead of acting as a distributor, Protea's co-marketing partner, Waters Corp., will sell the LAESI DP-1000 instrument alongside their mass spectrometers. And while Protea has not characterized the sales proposition as such, we view LAESI DP-1000 as a competitive upgrade for Waters' instruments. DP-1000 is already compatible with some of Waters' and Thermo Fisher's instruments. Protea is currently working on adapter kits for other instruments and we expect the company will likely look to enter into similar co-marketing arrangements with other of the mass spectrometer OEMs.

FINANCIALS

Balance Sheet / Cash Flow
As of the most recent reporting period (12/31/2014) the company had $323k in cash and equivalents. They estimate that they will need ~$8.55 million in additional capital (in addition to cash from operations) to maintain operations through the end of the current year. We expect future equity and debt financings to help fund ongoing operations, the roll-out of LAESI DP-1000 and, potentially, further build-out of the lab services operations.

Cash burn has averaged approximately $1.6 million over the last 12 months. We expect cash burn may increase over the near term as Protea funds working capital, particularly inventory of its LAESI DP-1000 instrument, and activities associated with the accelerated sales and marketing efforts.

At year-end 2014 there was a total of approximately $7.7 million of debt outstanding which includes $3.0 million drawn under a $3.0 million line of credit, $2.8M in debt and loans maturing within one year (included in this is $1.4M payable to stockholders) and $1.8M in long-term debt.

INVESTMENT SUMMARY

✧**LAESI - Revolutionary, Award-Winning Technology**
LAESI is a revolutionary technology in that it allows the direct analysis of biological samples of all types without the need for sample preparation and does so in an ambient environment, providing it with unmatched capabilities compared to other ionization methods. MALDI ionization, perhaps the most widely used method for life sciences applications, requires sample preparation and the use of a matrix which can cause interference, skewed results and sample loss. The sample preparation process also reduces throughput due to the significant additional handling time required with a matrix application. MALDI is also used in a vacuum, precluding its use on live cells and bacterial colonies. LAESI does not suffer these same drawbacks as lack of sample preparation eliminates those associated risks and since it is used in a non-vacuum environment, it is appropriate for analysis of live cells. As LAESI does not destroy or otherwise compromise the sample, the sample can be used for future analysis.

LAESI also appears superior with mass spectrometry imaging, providing superior images (particularly for smaller molecules) and with the ability to capture 3D images - both of which are clear advantages. Lack of sample preparation also affords mass spectrometry with LAESI to be fully automated and produce results up to ten times faster than when using other ionization methods.

The robustness of the technology is supported by numerous published experiments and case studies as well from awards from the scientific community (Frost & Sullivan, Pittcon, etc.). 40+ peer-reviewed publications describe the use of the LAESI technology with a variety of sample types (including live cells) and for numerous applications.

✧**Molecular Information Services - Unique and Highly Capable**

Protea's molecular information services offerings is perhaps unmatched in the scope and depth of capabilities related to direct molecular imaging and related analytics. It is the only lab in the world that offers the complementary platforms of LAESI and MALDI under one roof. In addition, mass spectrometry imaging is quickly gaining interest for various applications but requires expensive equipment and highly trained personnel to perform it and analyze the results. As such, MSI is out of reach to most laboratories and research institutions, which offers real opportunities for Protea. With state-of-the-art equipment including LAESI and MALDI mass spectrometers, proprietary MSI software including their ProteaPlot software, and highly trained personnel, Protea believes their molecular information services business has unmatched capabilities in mass spectrometry and MSI.

Protea has already scored contract work from cancer research institutions related to biomarker discovery and global biopharmaceutical companies related to preclinical drug development. The company has acquired 20+ unique customers since 2013. Protea envisions further contracts from biotechnology / pharmaceutical / universities / government agencies related projects such as biomarker discovery and preclinical drug trials (particularly in areas such as oncology and neurodegenerative diseases - difficult to diagnose diseases with large markets) which could eventually culminate in the development of commercialized products such as novel drugs or diagnostic assays.

✧ **Molecular Data and Informatics Products – World Class Collaborators Already Secured**

In 2014 Protea announced two research collaborations with the goal of using LAESI for new biomedical discoveries. The first collaboration announced in April 2014 with Memorial Sloan Kettering Cancer Center and Dana-Farber Cancer Institute will apply LAESI to the study of lung cancer. In May Protea announced its collaboration with the University of Southampton (U.K.) which is focused on applying LAESI to the study of Alzheimer's disease.

Then in early July Protea penned another agreement which is also directly focused on bringing new products and services to market through leveraging their expertise and the unique advantages of the LAESI platform. Under this collaboration with InSphero AG, the leading supplier of 3D organotypic microtissues, the companies will use LAESI (and its 3D capability) and InSphero's proprietary 3D microtissues to create 3D molecular profiles for research applications, including for drug discovery. The duo expects to generate new products and services from the partnership which will then be co-marketed to medical researchers, including InSphero's current customer base which includes the top ten pharma and cosmetic companies. Given InSpero's leading position in 3D microtissues, we see this collaboration as validation of the utility of high-performance 3D imaging in medical research and drug discover and the related capabilities of Protea and LAESI in this space.

R&D-related activities kicked-off immediately following the collaboration agreement and in October PRGB presented first data borne out of the partnership at an InSphero users meeting in San Francisco. The data is from experiments using LAESI and Protea's complementary modalities in the mass spec imaging of InSphero's 3D microtissues, including those grown from a colon cancer cell line. These early results are significant as they demonstrate Protea's ability in identifying and analyzing proteins and lipids in various 3D microtissues. These experiments are expected to be the precursors to eventual commercialization of new products and services. Additional data will be presented at a November 20th user meeting. We think initial revenue related to this collaboration could materialize within the next 12 months.

These collaborations are consistent with Protea's focus on medical research applications including oncology and neurodegenerative diseases. We think it is likely that additional collaborations will be announced in the near term. The IP generated from these and future collaborations could result in new revenue opportunities for the company.

✧**Mass Spec Market - Rapidly Growing, Particularly in Life Sciences Research**

Protea's sweet-spot, for both its LAESI DP-1000 instrument as well as their molecular information services, is life sciences research. Mass spectrometry demand is expected to exhibit high single digit growth for at least the next four years with demand from the life sciences market expected to be close to double-digits over the same timeframe. As LAESI has broad applications (which are supported by published experiments) in not just in life sciences but in other industries as well, Protea's products and services are also well positioned to capitalize on the expected growth in mass spectrometry and mass spectrometry imaging in other areas, including agriculture/food, forensics, and industrial applications.

✧**Commercialization Underway**

Protea sold the first LAESI DP-1000 instrument in late 2012. Through the end of 2014 they had sold ten units but we expect the placement curve to steepen, facilitated by greater awareness of the technology particularly in areas of medical research and the recent hiring of key sales and marketing personnel. In March 2012 Protea entered a non-exclusive co-marketing agreement with Waters Corp., the fourth largest mass spectrometer manufacturer. Protea will look to partner with other mass spectrometer manufacturers (similar to the arrangement with Waters) which would greatly expand their potential footprint and likely spark a greater rate of unit sales growth.

Protea also just recently transitioned manufacturing of the instrument outside to a contract manufacturer. This should have the effect of reducing manufacturing time and cost and improve gross margins on the instruments (which we expect will be at about 50%).

✧**Experienced Management Team**

The company is lead by a management team with significant experience in mass spectrometry, advanced imaging, assay development and business development of life sciences companies. The management team has deep ties to the mass spectrometry industry and includes those which had high level positions at some of the largest mass spec manufacturers in the world. We think this not only provides credibility to Protea's technology and service-based capabilities but also likely provides a Rolodex of key industry contacts which should aid the sales efforts.

VALUATION / RECOMMENDATION

While LAESI instrument sales have provided the bulk of Protea's revenue to-date and are expected to continue to be a meaningful contributor to the top-line in the remainder of the current year and beyond, services related revenue, which made a meaningful contribution in 2014, is where we view the most significant opportunity for growth. The company has drawn interest in its expertise and technological capabilities from the life sciences as well as other industries, including chemical and agricultural. Protea has already begun to score services-related contracts and entered into collaborations with high-profile partners related to research on cancer, Alzheimer's disease and other conditions. With 20+ new customer wins since just 2013, meaningful services-related revenue already booked in 2014, additional services-related sales reps recently hired and expectations of consummating additional near-term collaborative agreements, we think the services business may be poised to show a rapidly steepening revenue curve.

Services revenue accounted for 16% of total revenue in 2013 which grew to 29% in 2014. We model approximately $4.2 million of revenue in the current year, which includes a greater contribution from services. Our out-years assume an even higher proportion of revenue comes from the services side, including approximately 66% of our 2018 estimate of $22.0 million.

We use a DCF model to value Protea. Key inputs include 10-year revenue CAGR of 47%, 10% discount rate, and 2% terminal growth rate. Based on our 10-year DCF, PRGB is valued at approximately $1.80/share. We are maintaining our Outperform rating.

Risks

The initial roll-out of LAESI as well as the company's services-related business are still in their infancy. And while we believe the benefits and competitive advantages of the technology and the unmatched scope, depth and expertise of the services business has the potential to attract significant demand (primarily for medical research) and eventually push the company to profitability, there are substantial near-term risks. These include that the company has generated relatively insignificant revenue to-date, has a cash-burn rate that is averaging approximately $1.6 million per quarter, has a substantial amount of debt (including almost $6 million listed as current debt) and only a minimal amount of cash as of the most recent reporting period (12/31/2014).

FINANCIAL MODEL

Protea Biosciences

	2014 A	Q1E	Q2E	Q3E	Q4E	2015 E	2016 E	2017 E	2018 E
Total Revenues	$1,768.3	$519.0	$819.0	$1,227.0	$1,632.0	$4,197.0	$9,747.6	$14,772.7	$21,999.6
YOY Growth	*44.5%*	*10.9%*	*136.3%*	*137.1%*	*274.2%*	*137.3%*	*132.3%*	*51.6%*	*48.9%*
COGS	$871.9	$245.22	$407.2	$562.3	$764.2	$1,978.9	$4,265.3	$6,282.3	$9,211.1
Gross Income	$896.4	$273.8	$411.8	$664.7	$867.8	$2,218.1	$5,482.3	$8,490.4	$12,788.5
Gross Margin	*50.7%*	*52.8%*	*50.3%*	*54.2%*	*53.2%*	*52.9%*	*56.2%*	*57.5%*	*58.1%*
SG&A	$8,736.5	$2,188.0	$2,214.0	$2,268.0	$2,315.0	$8,985.0	$10,318.0	$11,266.0	$12,099.8
% SG&A	*494.1%*	*421.6%*	*270.3%*	*184.8%*	*141.9%*	*214.1%*	*105.9%*	*76.3%*	*55.0%*
R&D	$2,853.1	$512.0	$546.0	$481.0	$604.0	$2,143.0	$2,355.0	$2,488.0	$2,881.9
% R&D	*161.3%*	*98.7%*	*66.7%*	*39.2%*	*37.0%*	*51.1%*	*24.2%*	*16.8%*	*13.1%*
Operating Income	($10,693.1)	($2,426.2)	($2,348.2)	($2,084.3)	($2,051.2)	($8,909.9)	($7,190.7)	($5,263.6)	($2,193.2)
Operating Margin	*-604.7%*	*-467.5%*	*-286.7%*	*-169.9%*	*-125.7%*	*-212.3%*	*-73.8%*	*-35.6%*	*-10.0%*
Total Other Income (Expense)	($781.7)	($144.0)	($126.0)	($108.0)	($102.0)	($480.0)	($440.0)	($395.0)	($600.0)
Pre-Tax Income	($11,474.8)	($2,570.2)	($2,474.2)	($2,192.3)	($2,153.2)	($9,389.9)	($7,630.7)	($5,658.6)	($2,793.2)
Tax expense (benefit)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Tax Rate	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Preferred dividends	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Net Income	($11,474.8)	($2,570.2)	($2,474.2)	($2,192.3)	($2,153.2)	($9,389.9)	($7,630.7)	($5,658.6)	($2,793.2)
YOY Growth	*0.5%*	*-5.9%*	*-28.2%*	*-52.9%*	*18.3%*	*-18.2%*	*-18.7%*	*-25.8%*	*-50.6%*
Net Margin	*-648.9%*	*-495.2%*	*-302.1%*	*-178.7%*	*-131.9%*	*-223.7%*	*-78.3%*	*-38.3%*	*-12.7%*
EPS	($0.17)	($0.03)	($0.02)	($0.02)	($0.02)	($0.09)	($0.06)	($0.04)	($0.02)
YOY Growth	*-33.2%*					*-44.0%*	*-31.8%*		
Diluted Shares O/S	67,763	81,500	100,100	105,000	109,800	99,100	118,000	126,200	129,150

Brian Marckx, CFA

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LEADERSHIP

Management

Stephen Turner is Chief Executive Officer and Chairman of the Board, positions he has held since founding the company in July, 2001. From 1999 to 2001 he served as President and CEO of Quorum Sciences, Inc. From 1984 to 1997 he was President and CEO of Oncor, Inc. He founded Bethesda Research Laboratories, Inc. in 1975 and served as its Chairman and CEO from 1975 to 1983, at which time BRL became the molecular biology division of Life Technologies, Inc. Prior to commencing his career in biotechnology, Mr. Turner held the position of Director of Marketing for the Clinical Microbiology Division of Becton, Dickinson & Co. He received his B.A. from Stanford University in 1967. In 1994 he received the Ernst & Young Entrepreneur of the Year Award in Life Sciences for the Washington D.C. Region.

Greg Kilby Ph.D. is Protea′s Chief Bioanalytics Officer. Dr. Kilby has over 18 years of experience in applying advanced biological mass spectrometry to areas of research including structural biology, protein characterization, and proteomics to support drug discovery and development and to support the sales of liquid chromatography mass spectrometry (LCMS) analytical equipment into the life sciences, government, academic, and applied markets in the Americas. Prior to joining Protea, Dr. Kilby held a position in Thermo Fisher Scientific of Director, North America Life Sciences Mass Spectrometry Application and Demonstration Laboratories, leading a team responsible for providing product demonstrations and application services to support quota performance and business growth of the Thermo Scientific life sciences mass spectrometry portfolio in North America. Before joining Thermo Fisher Scientific in 2012, Dr. Kilby held several positions in Agilent Technologies, starting as a senior Proteomics and BioPharma applications scientist as well as being responsible for developing and implementing two state of the art Demonstration Centers of Excellences (COE) in Wilmington DE and Santa Clara CA, showcasing Agilent′s entire breadth of analytical technologies portfolio. In 2007, Dr. Kilby moved to a management position within Agilent responsible for managing the two COE facilities and two satellite laboratories across North America and the respective mass spectrometry applications scientist, administrative and logistics staff. Prior to his work at Agilent, Dr. Kilby held, from 1998 to 2004, several senior positions in the Discovery Technologies Department with Pfizer Global Research & Development, culminating in Research Associate, responsible for leading a team of scientists to provide advanced mass spectrometry support for structural biology and therapeutic area projects and as part of Pfizer's global proteomics center of emphasis (COE). Dr. Kilby received his Ph.D. in Analytical Chemistry from the University of Wollongong, Australia in 1996.

Edward Hughes is Chief Financial Officer, and has served in this position since April 2010. Prior to this position he was CFO of Microbac Laboratories, Inc., an environmental and food testing company based in Pittsburgh, Pennsylvania from February, 2003 through March 2009. Prior to that, he was CFO of Silliker Group Corporation, a food testing company based in Greater Chicago. From 1987 to 1998 Mr. Hughes was employed by Rhone Poulenc Rorer, where he was Manager, Financial Planning and Analysis (1987-88), Assistant Controller – Research and Development (1988-1991), Finance Director Asia/Pacific (1991-1996), and Corporate Finance Director (1997-1998). He is currently a Board member of the Pittsburgh Chapter of Financial Executives International.

Matthew Powell, Ph.D. is Protea's Director, Research & Development and Chief Science Officer. He received his Ph.D. in Analytical Chemistry from West Virginia University in 2005. Dr. Powell's expertise is in the field of biological mass spectrometry and is a co-inventor of certain technologies developed by the Company. Dr. Powell has presented to several scientific talks and seminars to international audiences; most recently as a guest lecturer for AnalytiX 2013 in Suzhou, China.

Board of Directors

Steven Antoline joined the Board of Directors in April 2010. He is a successful owner, developer and manager of coal and natural resource properties and inventor of new equipment for coal mining. From 1996 to 2006, he was President and owner of Superior Highwall Mining, Inc., which was sold to a partnership comprised of Lehman Bros. (60%) and Tennessee Valley Ventures (40%). Mr. Antoline was appointed to serve as a director of the Company because of his prior experience in the development and sale of companies, and in working with investment bankers.

Josiah T. Austin joined the Board of Directors on January 28, 2013 and has served as the managing member of El Coronado Holdings, L.L.C., a privately owned investment holding company which invests in public and private companies. He and his family own and operate agricultural properties in the states of Arizona, Montana, and northern Sonora, Mexico through El Coronado Ranch & Cattle Company, L.L.C. and other entities. Mr. Austin previously served on the Board of Directors of Monterey Bay Bancorp of Watsonville, California, and is a prior board member of New York Bancorp, Inc., and North Fork Bancorporation. He has served as a director of Goodrich Petroleum, Inc. since April 2002 and was named to the Board of Directors of Novogen Limited in September 2010. Mr. Austin also serves as a trustee of the Cuenca Los Ojos Foundation Trust, a non-profit organization working to preserve and restore the biodiversity of the borderland region between the United States and Mexico through land protection, habitat restoration and wildlife reintroduction. Mr. Austin graduated from the University of Denver with a Bachelor of Science in Finance in 1971.

Leonard Harris has been a member of the Board of Directors since April 2003. Since 1977 he is the founder and Chief Executive Officer of Southern Computer Consultants, Inc. located in Frederick, Maryland, a company which provides products and services to the United States government and Fortune 500 corporations. Mr. Harris' extensive experience in technology-based corporate development, which provides support and guidance to the Company's LAESI instrument platform, led the board to determine that he should serve as a director of the Company.

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Stanley Hostler is Vice President, Secretary and Director. He has been a Director of the Company since January 2006 and Vice President and Secretary since June 2006. Mr. Hostler is an attorney with a career practice in the field of labor and employment law. From 2000 to 2010 he served as Special Assistant to the Governor of the State of West Virginia. From 2002 to 2004 he served as Counsel to the Prim Law Firm. From 2000 to 2010 he served on the West Virginia University Foundation Board of Directors, and from 1995 to 2010 on the Advisory Committee of the WVU School of Medicine. He is a Graduate of the West Virginia University School of Law (1965). Mr. Hostler's legal experience and business contacts and relationships with West Virginia University and the State of West Virginia have been an asset to the Company and led the board to determine that he should serve as a director of the Company.

Roderick Jackson joined the Board of Directors in January 2011. From 2005 to 2009 he was the founder, Chairman and Chief Executive Officer of Cobalt Laboratories, and from 2005 to 2009 a member of the Board of Directors of The Arrow Group, based in the United Kingdom. In June 2009 Cobalt Laboratories was sold, along with the Arrow Group, to Watson Pharmaceuticals. From 1986 to 2002 he was employed by Mylan Laboratories, Inc., first as Vice President Marketing and Sales (1986-1992) then as Senior Vice President and Member of the Office of the President (1992-2002). He received his B.B.A. from Texas A&M University. Mr. Jackson's experience in the development of marketing agreements both in the U.S. and internationally, which is beneficial to the Company as it seeks to market its products, led the board to determine that he should serve as a director of the Company.

Ed Roberson joined the Board of Directors in September 2009. From July 2006 to June 2010 he served as Chairman of the Board of the Methodist Healthcare System. He received his MBA in accounting in 1972 from the University of Georgia. From 2006-2011 he was President of Beacon Financial in Memphis, Tennessee, and from 2006-2007 President of Conwood LLC. He has been a Director of the Paragon National Bank from 2004 to present. From 1972 to 1992, Mr. Roberson was employed by KPMG, most recently as partner. Mr. Roberson's experience, both as a Partner with KPMG and subsequently as a CEO, led the Board to determine that he should serve as a director of the Company.

Scott Segal joined the Board of Directors in February 2008. He is a practicing attorney, specializing in the fields of personal injury, product liability and related matters, and is the President of the Segal Law Firm, Charleston, West Virginia. He received his JD from the West Virginia University School of Law in 1981, and has been a member of the American Bar Association from 1981 to present. Mr. Segal has extensive relationships within the State of West Virginia and is considered by the Company to be an expert in several areas which may have use for the Company's technology, including forensics and occupational health, which led the Board to determine that he should serve as a director of the Company.

C. Andrew Zulauf joined the Board of Directors in June 2012. He is Executive Director of the West Virginia Jobs Investment Trust (WVJIT) and has served in such capacity since March, 2009. WVJIT is a Charleston, West Virginia-based public venture capital firm created by the West Virginia Legislature in 1992 to promote new businesses in West Virginia. Previously, from 2006 to 2009, Mr. Zulauf was Vice President and Upper Middle Market Commercial Relationship Officer for Fifth Third Bank, headquartered in Cincinnati, Ohio. Mr. Zulauf was Partner and Managing Director of West Virginia Operations for Adena Ventures based in Athens, OH from 2002 to 2006, and Executive Director and Senior Loan Officer at the West Virginia Capital Corporation in Charleston, West Virginia from 1994 to 2002. Mr. Zulauf's experience promoting new businesses in the area and his relationship with WVJIT, a stockholder and lender to the Company, led the Board to believe that Mr. Zulauf should serve as a director on the Board. Mr. Zulauf is a 1985 graduate of Marshall University and in 1994 received his MBA from the University of Charleston's Executive MBA program.

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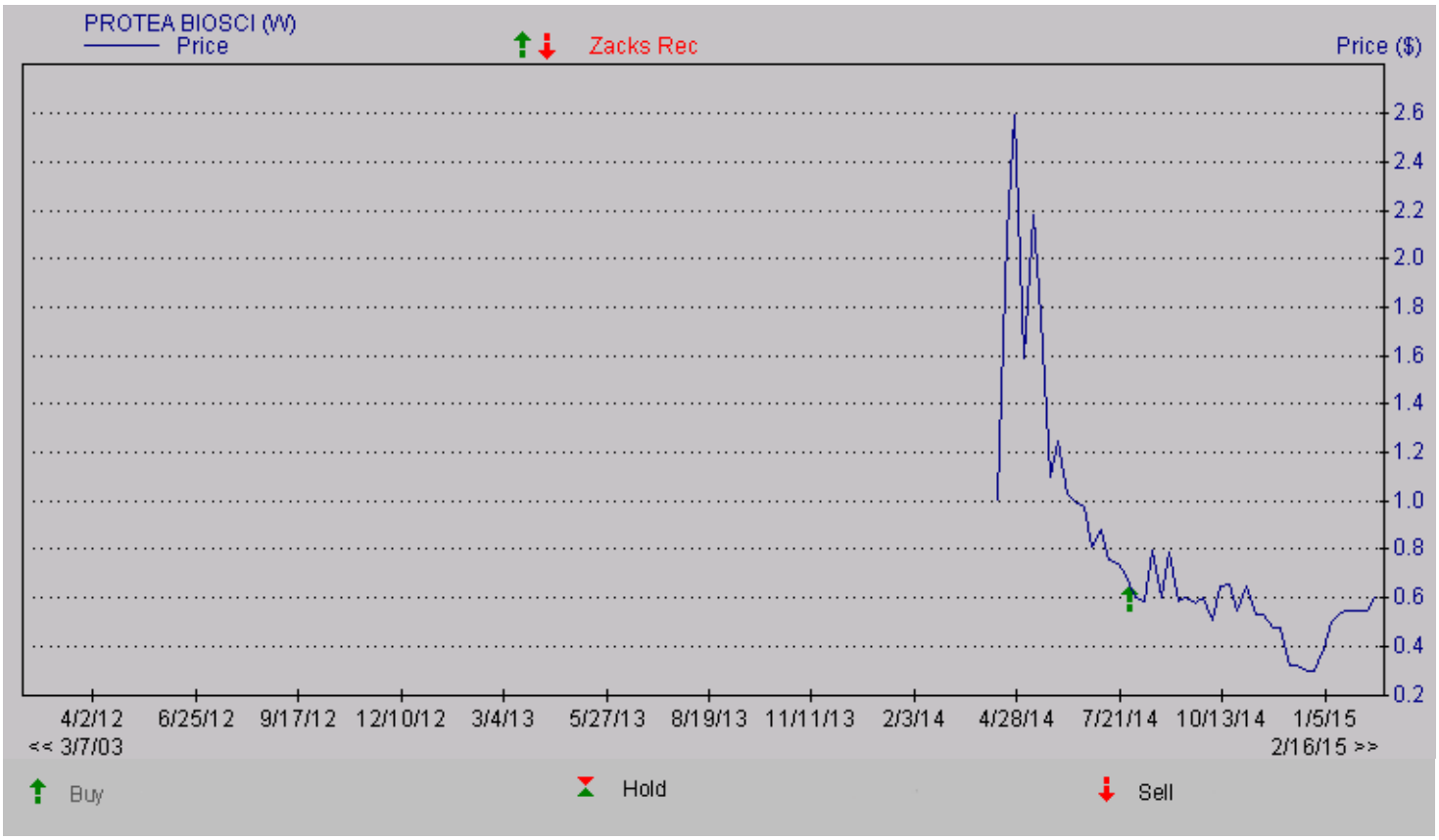

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