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Company Report

May 27, 2014

Protea Biosciences Group (PRGB - $ 1.10)

Initiating Coverage with BUY Rating

Healthcare / Medical Technology

Ticker:	**PRGB**
Rating:	**Buy**
Price Target:	**$ 4.50**

We are initiating coverage on Protea Biosciences Group, a medical device company focused on molecular imaging, with a BUY rating and $4.50 price target.

- **Innovative Technology.** Protea's proprietary technology, Laser Ablation Electrospray Ionization (LAESI) mass spectrometry with molecular visualization capabilities and bioinformatics, delivers molecular intelligence solutions that improve outcomes in the fields of preclinical drug discovery, biomarker discovery and ultimately clinical medicine. LAESI is intended to meet the broad need of the researchers for the direct, unbiased identification and characterization of biomolecules in biological samples. By eliminating sample preparation, the biological sample can be analyzed without the possible contamination, bias or sample loss that occurs with the current techniques. LAESI enables the analysis of live cells and bacterial colonies. Data is available in seconds to minutes, allowing rapid time to results and the capacity to analyze thousands of samples in a single work period.
- **Two Pronged Sales Approach, Products and Services.** The LAESI DP-1000 is currently compatible with 3,000 mass spectrometers worldwide from Waters Corp. and Thermo Fisher Scientific. Protea intends to work towards making the LAESI DP-1000 compatible with a larger number of mass spectrometers through integration with other mass spectrometry vendors. We project the company will sell 10 LAESI DP-1000 units in 2014 and over 350 units in 2020. We estimate Protea's product sales will be $1.5 million in 2014, $3.3 million in 2015 and almost $55 million in 2020. Protea's Molecular Information Services is a portfolio of services provided to the pharmaceutical, biomarker discovery and agriculture markets. Protea is applying LAESI to create large cell-based biomolecular databases that will be specific to disease states and allow the analysis and integration of LAESI biomolecular datasets with the sample-related pathology, gene expression and demographic datasets. We believe the Molecular Services unit will generate 2014 sales of $1.1 million growing to $47.3 million by 2020.
- **Substantial Target Markets.** Through its instruments and services, Protea is positioned in the preclinical pharmaceutical research and biomarker discovery markets. The preclinical drug R&D market is estimated at over $14.5 billion annually. The biomarker discovery market is estimated to be a $13 billion annual global market. Protea's services unit intends to focus on efficacy studies, drug metabolism and pharmacokinetics in this market.

Trading Data:

Last Price (05/23/2014)	$ 1.10
52–Week High (4/29/2014)	$ 5.00
52–Week Low (4/14/2014)	$ 0.91
Market Cap. (MM)	$ 72
Shares Out. (MM)	66

Earnings Estimates: (per share)

(Dec)	1Q	2Q	3Q	4Q	FY	P/E
FY_15E	NA	NA	NA	NA	-0.13	NM
FY_14E	-0.04A	-0.04	-0.04	-0.04	-0.17	NM
FY_13A	-0.08	-0.07	-0.06	-0.05	-0.25	NM
FY_12A	-0.11	-0.09	-0.08	-0.06	-0.33	NM

Source: Laidlaw & Company estimates

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Investment Conclusions

LAESI delivers molecular intelligence solutions that improve outcomes in the fields of preclinical drug discovery, biomarker discovery and ultimately clinical medicine

- **Disruptive Technology**. Protea's proprietary technology, Laser Ablation Electrospray Ionization (LAESI) mass spectrometry with molecular visualization capabilities and bioinformatics, delivers molecular intelligence solutions that improve outcomes in the fields of preclinical drug discovery, biomarker discovery and ultimately clinical medicine. This technology enables the direct identification of proteins, lipids and metabolites in tissue, cells and biofluids, such as serum and urine, without any sample preparation prior to analysis. LAESI is intended to meet the broad need of the researchers for the direct, unbiased identification and characterization of biomolecules in biological samples. By eliminating sample preparation, the biological sample can be analyzed without the possible contamination, bias or sample loss that occurs with the current techniques, which require the introduction of chemicals, or the destruction of the sample itself, in order to enable analysis by mass spectrometry. LAESI enables the analysis of live cells and bacterial colonies. It can display the data obtained by mass spectrometry analysis combined with actual images of the tissue and cell samples. Three-dimensional (3D) imaging of molecular distributions offers insight into the correlation between biochemical processes and the spatial organization of a biological tissue. Thus, mass spectrometry data can be evaluated in the context of the biology of the sample; this allows the integration of mass spectrometry data with current pathology and microscopic imaging techniques. Data is available in seconds to minutes, allowing rapid time to results and the capacity to analyze thousands of samples in a single work period.

To date, the company has sold 7 LAESI DP-1000 units

- **Potential Exponential Product Sales Growth.** To date, the company has sold 7 LAESI DP-1000 units, including one in April to Dow Chemical. We believe the sale to Dow is important as it indicates that LAESI technology can provide value to agriculture and chemical companies, two underserved and underpenetrated markets for mass spectrometry. Protea's products and services are marketed worldwide utilizing a combination of field sales, distributors, in-house sales support and web-based marketing. On the products side, Protea currently has two sales reps and it plans on adding another four this year. Sales regions and responsibilities may overlap between products and services. The LAESI DP-1000 is currently compatible with 3,000 mass spectrometers worldwide from Waters Corp. and Thermo Fisher Scientific. Protea intends to work towards making the LAESI DP-1000 compatible with a larger number of mass spectrometers through integration with other mass spectrometry vendors such as Danaher's AB Sciex unit, Bruker and Agilent. In March 2012, the company executed a non-exclusive co-marketing agreement with Waters and it may seek to execute additional agreements of similar nature. The global mass spec instrument market was approximately $3.4 billion in 2013 and it is

The LAESI DP-1000 is currently compatible with 3,000 mass spectrometers worldwide from Waters Corp. and Thermo Fisher Scientific

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expected to reach $3.9 billion by 2015, growing at a CAGR of 7.8% from 2011 through 2015. Protea had been manufacturing LAESI in-house until 2013, when it hired a contract manufacturing firm. We do not expect any capacity constraints. Due to cost savings from the contract manufacturing as well as engineering and design improvements, the company has been able to lower the list price on the LAESI DP-1000 system to $175,000 from $190,000. We expect the company will continue to make improvements in production designs that could lead to a smaller unit size, lower price point, and improved performance. We project the company will sell 10 LAESI DP-1000 units in 2014, 22 in 2015 and that it will sell over 350 units in 2020. We estimate Protea's product sales will be $1.5 million in 2014, $3.3 million in 2015 and almost $55 million in 2020.

We project the company will sell 10 LAESI DP-1000 units in 2014, 22 in 2015 and that it will sell over 350 units in 2020

- **Establishing Leading Molecular Information Services Business.** Protea's Molecular Information Services is a portfolio of services provided to the pharmaceutical, biomarker discovery and agriculture markets. The company offers proprietary LAESI imaging services for the rapid identification of both small molecules and large molecules. Besides LAESI, the services business offers MALDI (matrix-assisted laser desorption ionization) mass spectrometry imaging and other mass spectrometry techniques. The services unit is operated under Good Laboratory Practices (GLP). Protea is building a direct sales force to market and sell its services to pharmaceutical companies, academic/clinical research laboratories and other industrial/chemical companies that are interested in Protea's mass spectrometry imaging capabilities and expertise. Protea is applying LAESI to create large cell-based biomolecular databases that will be specific to disease states and allow the analysis and integration of LAESI biomolecular datasets with the sample-related pathology, gene expression and demographic datasets. It currently has 4 field sales and marketing representatives and we expect the company will expand to about a dozen reps by 2018. We believe the Molecular Services unit will be a fast growing business and project 2014 sales of $1.1 million growing to $47.3 million by 2020.

Protea is applying LAESI to create large cell-based biomolecular databases

- **Significant and Growing Markets.** Through its instruments and services, Protea is positioned in the preclinical pharmaceutical research and biomarker discovery markets. The preclinical drug R&D market is estimated at over $14.5 billion annually. The company's technology could potentially address 10% of that market or $1.5 billion by our estimate. Incorporating biomarker research into drug development can decrease time and capital investments for pharmaceuticals companies resulting in millions of dollars saved. The biomarker discovery market is estimated to be a $13 billion annual global market. Protea's services unit intends to focus on efficacy studies, drug metabolism and pharmacokinetics in this market. A secondary focus will be on toxicology studies. Protea's technology enables rapid generation of very large molecular datasets, which are used to improve pharmaceutical development and life science research outcomes, and to extend and add value to other technologies, including 3D tissue printing, biomarker discovery and synthetic biologicals. The LAESI DP-1000 generates large data files that are not only valuable to researchers now but also data that will be valuable in the future.

Protea is positioned in the preclinical pharmaceutical research and biomarker discovery markets

The company's technology could potentially address 10% of the $14.5 billion R&D market

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We believe Protea may be an attractive potential takeover target, either the company as a whole or just the instrument unit or the services unit

- **Potential Acquisition Target.** We believe Protea may be an attractive potential takeover target, either the company as a whole or just the instrument unit or the services unit. On the services side, we believe that the company is staffed with some of the most experienced laboratory personnel in the industry. We note that on November 7, 2011, Quintiles Transnational Holdings closed on the acquisition of Advion BioServices, a premier U.S.-based bioanalytical laboratory. Advion was acquired for $54.9 million. Advion provided GLP pharmacokinetic/pharmacodynamic (PK/PD) testing and other services to biopharma companies worldwide. Quintiles is a fully integrated biopharmaceutical services company. Quintiles' strong commitment to grow and expand its bioanalytical services globally was a key driver for the acquisition. Quintiles management stated that Advion's abilities to help companies gather early-stage data and gain insights aimed at reducing the risk of failure in expensive later-stage trials made it an attractive acquisition choice. This could also be said of Protea's services unit. Quintiles or any of its competitors may be attracted to Protea's services unit, though we have no knowledge of any company showing an interest in Protea's services unit. On the product side, LAESI is a new technology that could offer significant growth in a mass spec market that is growing in the single-digits. We believe one or more of the major mass spec companies (Agilent Technologies, Bruker Corp, Danaher Corp, Waters Corp, Thermo Fisher Scientific) could be interested in acquiring the LAESI technology. Note that in March 2012, the company executed a non-exclusive co-marketing agreement with Waters Corp.

We are initiating coverage on Protea with a BUY rating and $4.50 price target

- **Valuation.** We are initiating coverage on Protea with a BUY rating and $4.50 price target. We forecast sales will grow from $1.2 million in 2013 to $13.2 million in 2016 and over $100 million by 2020, an impressive revenue CAGR of 88.2% out to 2020. Our price target of $4.50 is based on 7.0x on the net present value of our revenue estimates. Due to its exponential growth potential, the multiple we use is slightly above the average of comparable companies including Foundation Medicine (a company that provides advanced molecular information that is used in clinical medicine and also by pharmaceutical companies to manage clinical trials) and platform companies in the genomics industry - NanoString Technologies, Fluidigm and Cepheid.

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Company Description

Protea applies its core technologies and expertise to the development of products and services that improve the discovery and identification of proteins, metabolites and other biomolecules

Protea Biosciences Group, Inc. is an "emerging growth company," as defined in the Jumpstart Our Business Startups Act of 2012 ("JOBS Act"), in the molecular imaging business. Protea applies its core technologies and expertise to the development of products and services that improve the discovery and identification of proteins, metabolites and other biomolecules, which are the products of all living cells and life forms. The company has developed a proprietary molecular information platform technology with broad applications in the pharmaceutical, diagnostic, agricultural and life science industries. Through a merger on September 2, 2011 with a "blank check" shell company, Protea became a Delaware corporation headquartered in Morgantown, West Virginia. The company is applying its molecular imaging technology to develop a new generation of products and molecular information services that enable more rapid and comprehensive analysis of living cells and biofluids. Its proprietary direct molecular analysis technology is useful to support medical research and pharmaceutical development. Protea has three major businesses: LAESI Instruments & Consumables Products, Molecular Information Services, and Molecular Database Products. The company's products and services are purchased and utilized primarily by pharmaceutical and academic/clinical research laboratories and are employed by analytical chemists, translational researchers, oncologists, pathologists and cell biologists. Its products and services are marketed worldwide utilizing a combination of field sales, distributors, in-house sales support and web-based marketing. In Europe and Asia, the company employs distributors who will purchase the products and resell them to customers in their territory. As of mid-March 2014, Protea had 47 full-time employees, consisting of 28 technicians and scientists (8 Ph.D. level), 8 management/administrative, 5 IT/software development, and 6 sales and marketing representatives.

The LAESI DP-1000 system provides a chemical mapping of biological samples

The company's Instruments & Consumables Products serve the bioanalytical market, in-particular laboratories that are using mass spectrometry as their core technology. The company believes that its strong IP position allows offering of unique products aimed to improve the efficiency of the analytical laboratories in drug discovery and development. The LAESI DP-1000 system provides a chemical mapping of biological samples. The system "bolts" onto the input end of mass spectrometers.

Mass spectrometry is an analytical technique that is used to determine the composition of a given sample based on the mass-to-charge ratio (m/z) of the biomolecules present in the sample. Mass spectrometers produce spectra of the masses of the atoms or molecules comprising a sample of material. The spectra are used to determine the elemental or isotopic signature of a sample, the masses of particles and of molecules, and to elucidate the chemical structures of molecules, such as peptides and other chemical compounds. Mass spectrometry works by ionizing chemical compounds to generate charged molecules or molecule fragments and measuring their mass-to-charge ratios. In a typical mass spec procedure, a sample, which may be solid, liquid, or gas, is ionized by

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bombarding it with electrons. This may cause some of the sample's molecules to break into charged fragments. These ions are then separated according to their mass-to-charge ratio, typically by accelerating them and subjecting them to an electric or magnetic field. Ions of the same mass-to-charge ratio will undergo the same amount of deflection. The ions are detected by a mechanism capable of detecting charged particles, such as an electron multiplier. Results are displayed as spectra of the relative abundance of detected ions as a function of the mass-to-charge ratio. The atoms or molecules in the sample can be identified by correlating known masses to the identified masses or through a characteristic fragmentation pattern. Mass spectrometry is often associated with leading edge science in a variety of industries. Mass spectrometer instruments (mass specs) are used extensively in the biopharmaceutical, industrial, chemical, materials, forensics, environmental science, cosmetics, biodefense and agriculture industries as well as in academic research institutions. Protea is focused on developing and marketing instruments, software, products and services that enhance the capabilities and applications of mass spectrometers for end users in all of these segments.

Mass spectrometry is often associated with leading edge science in a variety of industries

Figure 1: The LAESI DP-1000

Source: Company reports

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In a 2008 article in the *Journal of Analytical Chemistry*, scientists from the Department of Chemistry at George Washington University stated that mass spectrometry in conjunction with atmospheric pressure ionization methods enables the in vivo investigation of biochemical changes with high specificity and sensitivity. This group performed LAESI mass spectrometric analysis of chimeric Aphelandra squarrosa leaf tissue to identify the metabolites characteristic for the green and yellow sectors of variegation (altered appearance by adding different colors). Significant parts of the related biosynthetic pathways (e.g., kaempferol biosynthesis) were ascertained from the detected metabolites and metabolomics databases. Scanning electron microscopy of the ablated areas indicated the feasibility of both two-dimensional imaging and depth profiling with a 350 µm lateral and 50 µm depth resolutions. Molecular distributions of some endogenous metabolites showed chemical contrast between the sectors of variegation and quantitative changes as the ablation reached the epidermal and mesophyll layers. The group's results demonstrated that LAESI mass spectrometry opens a new way for ambient molecular imaging and depth profiling of metabolites in biological tissues and live organisms.

LAESI mass spectrometry opens a new way for ambient molecular imaging and depth profiling of metabolites in biological tissues and live organisms

Protea combines its proprietary technology, Laser Ablation Electrospray Ionization (LAESI) mass spectrometry, with molecular visualization capabilities and bioinformatics to deliver molecular intelligence solutions that improve outcomes in the fields of preclinical drug discovery, biomarker discovery and ultimately clinical medicine. LAESI can also be applied to other areas such as forensics, food or the agricultural industry. LAESI melds biology and chemistry. It is intended to meet the broad need of the biologist for the direct, unbiased identification and characterization of biomolecules in biological samples.

LAESI melds biology and chemistry

In 2008, Protea entered into an exclusive, worldwide license agreement with George Washington University for commercial rights to the LAESI technology. The company is pursuing what it believes will be a new era of human bioanalytics, where the molecular pathways of human disease will be more clearly illuminated, and datasets more rapidly available, thereby accelerating pharmaceutical and life science research. Protea's LAESI DP-1000 System revolutionizes sample introduction and data analysis for imaging and high-throughput biological mass spectrometry. A key advantage of LAESI is the access and visualization of molecules of interest directly as they exist and where they exist. The LAESI DP-1000 system allows fast and accurate direct ionization and mapping of biomolecules in biological samples and open well plates.

Protea's LAESI DP-1000 System revolutionizes sample introduction and data analysis for imaging and high-throughput biological mass spectrometry

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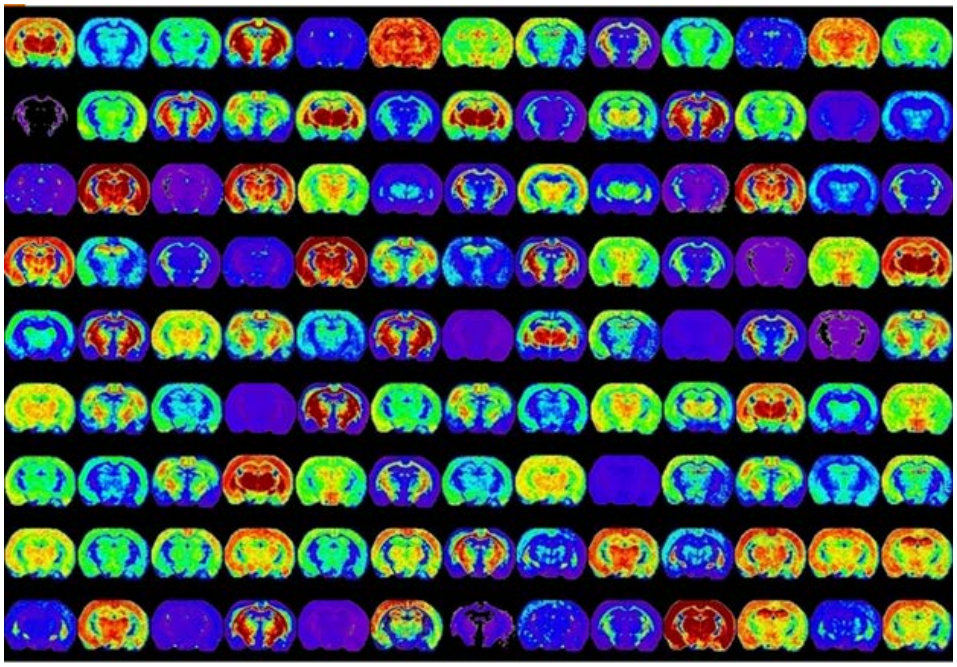
Figure 2: Representation of a LAESI Mass Spec Direct Molecular Image (Over 1,000 Distinct Molecules can be Identified in a Single Analysis)



Source: Company reports

LAESI enables mass spectrometric analysis of any sample containing water without the need for any additional sample preparation

The LAESI DP-1000 is attached to the front end of a mass spectrometer. It enables mass spectrometric analysis of any sample containing water without the need for any additional sample preparation. In a two-stage process, ambient pressure laser ablation and subsequent electrospray ionization enable mass spectrometric analysis of living cells and tissues, without the introduction of artifacts or sample degradation. This technology facilitates the direct identification of proteins, lipids and metabolites in tissue, cells and biofluids, such as serum and urine, without any sample preparation prior to analysis. By eliminating sample preparation, the biological sample can be analyzed without the possible contamination, bias or sample loss that occurs with the current techniques. LAESI can then display the data obtained by mass spectrometry analysis combined with actual images of the tissue and cell samples. Thus, mass spectrometry data can be evaluated in the context of the biology of the sample; this allows the integration of mass spectrometry data with current pathology and microscopic imaging techniques.

The lack of sample preparation also significantly speeds the mass spec process time

The lack of sample preparation also significantly speeds the mass spec process time. LAESI has the capacity to analyze thousands of samples in a single work period. Tissues are mapped in two- and three-dimensions (2D and 3D), displaying the molecular profile across the sample, or profiling the spatial distribution of intracellular molecules throughout the tissue. LAESI mass spectrometry imaging could become a major analytical method for biological investigation of tissues and living cell populations, such as cell cultures and colonies.

Protea had been manufacturing LAESI in-house until 2013, when it signed an agreement with Dynamic Manufacturing for contract manufacturing services.

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The company has been able to lower the list price on the LAESI DP-1000 system to $175,000 from $190,000

Protea sold five LAESI DP-1000 systems in 2013 and has sold two thus far in 2014. Due to cost savings from the contract manufacturing and engineering and design improvements, the company has been able to lower the list price on the LAESI DP-1000 system to $175,000 from $190,000. Protea believes that the LAESI DP-1000 is currently compatible with 3,000 mass spectrometers worldwide from Waters Corp. and Thermo Fisher Scientific. Protea intends to work towards making the LAESI DP-1000 compatible with a larger number of mass spectrometers through integration with other mass spectrometry vendors such as Bruker Corp. and Danaher's AB Sciex unit. In March 2012, the company executed a non-exclusive co-marketing agreement with Waters and it may seek to execute additional agreements of similar nature. On the products side, Protea currently has two sales reps and it plans on adding another four this year. Sales regions and responsibilities may overlap between products and services. We estimate Protea's product sales will be $1.5 million in 2014 and $3.3 million in 2015.

We estimate Protea's product sales will be $1.5 million in 2014 and $3.3 million in 2015

Molecular Information Services is a portfolio of services provided to the pharmaceutical, biomarker discovery and agriculture markets

The company's second business line, Molecular Information Services, is a portfolio of services provided to the pharmaceutical, biomarker discovery and agriculture markets. Protea offers proprietary imaging services for the rapid identification of both small molecules (e.g. lipids and metabolites) and large molecules (e.g. proteins). The services unit is operated under GLP (Good Laboratory Practices), which are necessary for regulatory submissions and to meet the internal research and development standards of pharmaceutical research clients. Protea is building a direct sales force to market and sell its services to pharmaceutical companies, academic/clinical research laboratories and other industrial/chemical companies that are interested in Protea's mass spectrometry imaging capabilities and expertise. Agriculture companies have been early clients. There are four services sales and marketing reps. The company leverages its unique technologies to offer complete support and innovative analytical approaches to companies looking to study bio-dynamics of drugs, their metabolites, or specific molecules indicative of a diseased condition. Pharmaceutical companies for example, can use Protea's services for the characterization of a drug, or research institutes can to advance their knowledge of a specific disease or condition with the assistance of Protea's services business.

Protea's services focus on the unique capability of LAESI technology to image and display the presence of specific biomolecules in cell and tissue samples

Protea's services focus on the unique capability of LAESI technology to image and display the presence of specific biomolecules in cell and tissue samples. Protea is applying LAESI to create large cell-based biomolecular databases that will be specific to disease states and allow the analysis and integration of LAESI biomolecular datasets with the sample-related pathology, gene expression and demographic datasets. It is developing "high resolution" LAESI technology that will enable the analysis of single cells. We believe LAESI can generate important advances in bioinformatics to help provide time-based, biodynamic datasets for improved disease state assessment and management.

Besides LASEI, the services business offers MALDI and other mass spectrometry techniques

Besides LASEI, the services business offers MALDI (matrix-assisted laser desorption ionization) mass spectrometry imaging and other mass spectrometry techniques. MALDI involves a soft ionization to visualize the spatial distribution of proteins, peptides, drug candidate compounds and other metabolites, biomarkers or other chemicals that utilizes a suitable MALDI matrix. The company recently bought a state-of-the art Bruker Ultraflex MALDI for over $700,000.

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The preclinical drug R&D market is estimated at over $14.5 billion

The preclinical drug R&D market is estimated at over $14.5 billion. Protea's management estimates its annual potential addressable market for preclinical drug R&D services at $1.5 billion, we concur with this assessment. Incorporating biomarker research into drug development can decrease time and capital investments for pharmaceuticals companies resulting in millions of dollars saved. The biomarker discovery market is estimated to be a $13 billion annual global market. Protea's services unit intends to focus on efficacy studies, drug metabolism and pharmacokinetics. A secondary focus will be on toxicology studies. We expect the Molecular Services unit will be a fast growing business and project 2014 sales of $1.1 million and $47.3 million by 2020.

The biomarker discovery market is estimated to be a $13 billion annual global market

The company's third business line is Molecular Database Products

The company's third business line is Molecular Database Products. This unit utilizes LAESI technology to create comprehensive, tissue and cell-based molecular information databases that will be specific to disease states and allow the integration of LAESI molecular datasets with related pathology, gene expression and demographic datasets, with the purpose of improving human disease state detection, assessment and management. Protea's technology generates very large databases of molecular information and it is not unusual to identify over 1,000 individual molecules in a single experiment. Larger databases aid the "molecular eyesight" of a researcher, improving their prospects to find new biomarkers or molecular data that will provide new research insight. The company develops scientific collaborations with key top-tier academic centers, such as Memorial Sloan-Kettering, to jointly discover and develop new therapeutic targets and disease specific biomarkers. The company's initial focus is the development of molecular information databases in the fields of oncology and neurodegenerative disease. We incorporate our revenue estimates for this business line with our services unit estimates.

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Laser Ablation Electrospray Ionization (LAESI) Mass Spectrometry

LAESI combines laser ablation from a mid-infrared (mid-IR) laser with a secondary electrospray ionization (ESI) process

Laser Ablation Electrospray Ionization (LAESI) is an ambient ionization method for mass spectrometry suited for the analysis of biological samples with sufficient water content. LAESI combines laser ablation from a mid-infrared (mid-IR) laser with a secondary electrospray ionization (ESI) process. The mid-IR laser is used to generate gas phase particles which are then ionized through interactions with charged droplets from the ESI source. LAESI was developed by Professor Akos Vertes of George Washington University in 2007 and is now marketed commercially by Protea.

In December 2008, Protea entered into an exclusive, worldwide license agreement with George Washington University for commercial rights to the LAESI technology. The agreement was amended in March, 2009 to include additional patent applications. LAESI is a new bioanalytical technology platform that enables rapid and direct identification of biomolecules in biological samples, without complex, time consuming and potentially altering sample preparation. This technology creates what we believe is a breakthrough capability to identify many different classes of compounds ranging from small molecules, such as pharmaceuticals, saccharides, lipids, metabolites to larger biomolecules like peptides and proteins and other biomolecules directly and rapidly. LAESI technology allows the direct identification of biomolecules in tissue sections and cells, so that the source sample is not destroyed. Because the source sample is preserved, proteins and metabolites can be identified and localized in cell structures, tissues and fluids. By eliminating sample preparation, the biological sample can be analyzed without the possible contamination, bias or sample loss that occurs with the current techniques that require the introduction of chemicals, or the destruction of the sample itself, in order to enable analysis by mass spectrometry. LAESI represents a minimally invasive/minimally destructive approach to chemical analysis, which means that living cells or tissues can be monitored not only in three dimensions, but also over time. This is important for pharmaceutical development, where changes in cell metabolism need to be analyzed to assess drug efficacy or toxicity.

LAESI technology allows the direct identification of biomolecules in tissue sections and cells, so that the source sample is not destroyed

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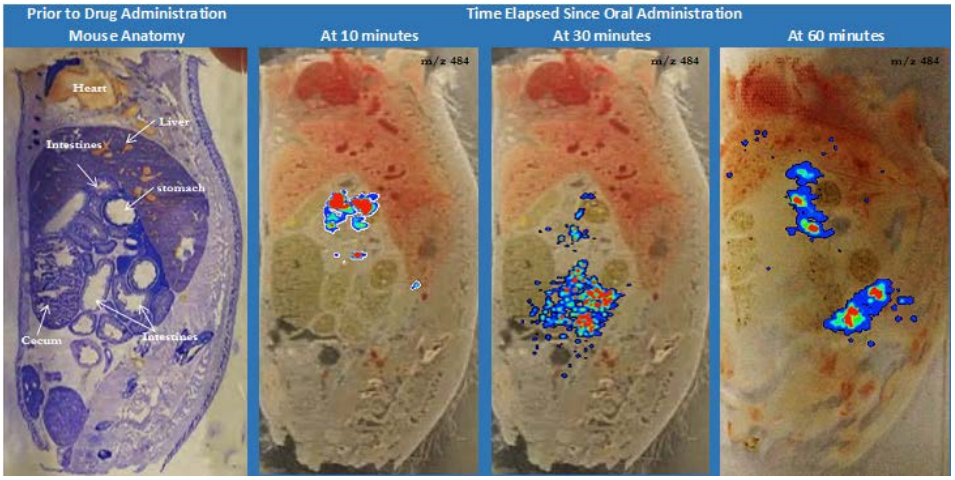
Figure 3: Time Course Study of a Drug Metabolized in a Mouse



Source: Company reports

LAESI provides 2D and 3D imaging data

Data from LAESI is available in seconds to minutes, allowing rapid time to results and the capacity to analyze thousands of samples in a single work shift. As an example, a researcher testing a new drug's effects on living cells can analyze changes in the cells' metabolism across a specific time course, thereby almost immediately obtaining data as to the activity of the new drug. Besides being extremely rapid, sensitive and quantitative, LAESI also provides 2D and 3D imaging data, showing the distribution of biomolecules across tissue sections and single cells. Three-dimensional imaging of molecular distributions offers insight into the correlation between biochemical processes and the spatial organization of a biological tissue.

LAESI is based upon the ablation of biological samples with a mid-infrared (MIR) laser that is tuned to the strong absorption line of water. Water-containing samples readily absorb the MIR laser energy, resulting in the production of an ablation plume above the sample, which interacts with an electrospray plume for secondary ionization of the sample molecules that are then swept into the mass spectrometer for detection.

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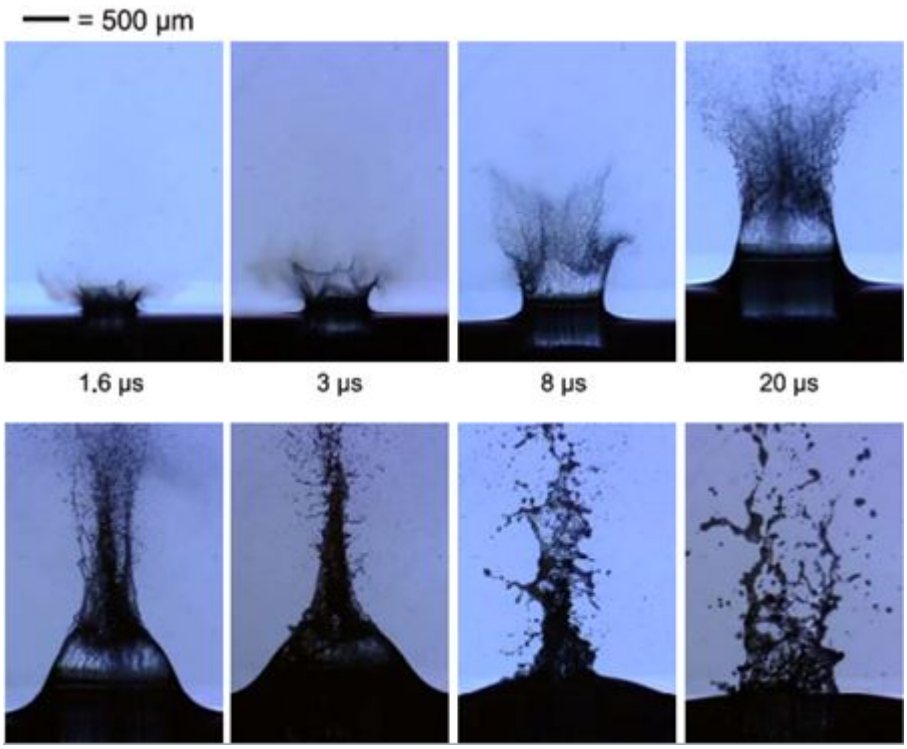
Figure 4: Diagram of an Ablation Plume Above the Sample



Source: Company reports

The technique has a lateral resolution of <200 µm for imaging applications

The entire sequence of events takes less than a second, and each analysis event produces mass spectral databases for the biomolecules present within that location on the sample (pixel). Each database produced may contain hundreds or thousands of biomolecule identifications. The technique has a lateral resolution of <200 µm for imaging applications and has been used for 3D imaging of plant tissues. Additionally, in cell-by-cell LAESI imaging experiments single cells can be used as the pixels of the molecular image. This LAESI application uses etched optical fibers to produce laser spot sizes of <50 µm to deliver the laser energy and has also been utilized in single cell analysis experiments. LAESI is performed at atmospheric pressure and therefore overcomes many of the obstacles of traditional mass spec techniques, including extensive and invasive sample preparation steps and the use of high vacuum pressure.

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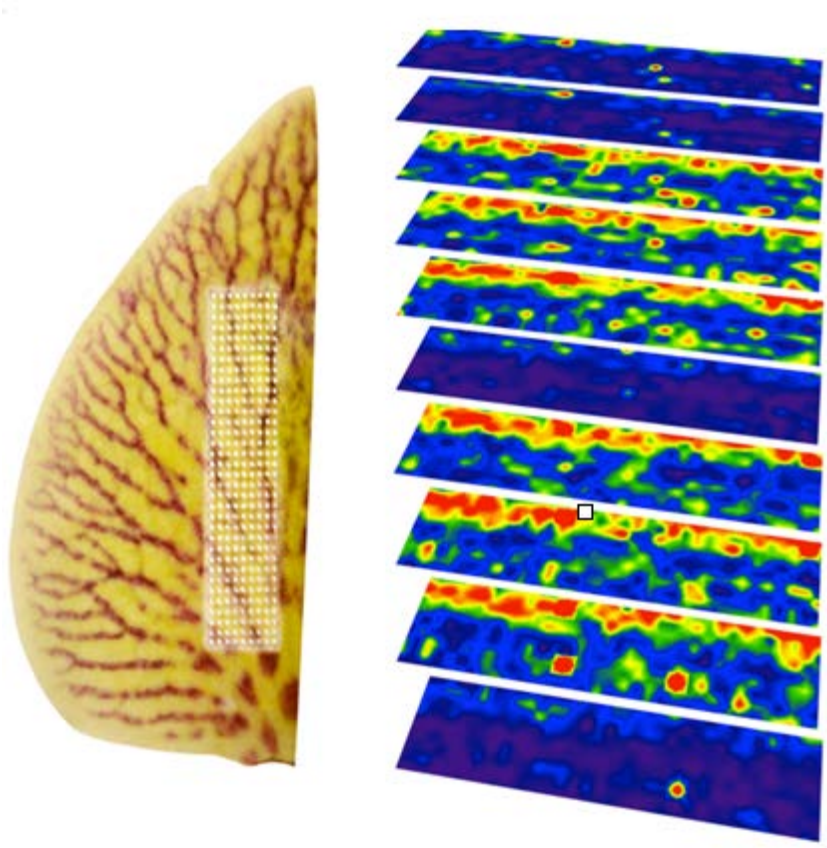
Figure 5: LASEI Three-Dimensional Ion Map Image of a Leaf, Displaying the Presence of a Chemical Herbicide in the Middle of the Leaf



Source: Company reports

Because LAESI operates at ambient pressure (non-vacuum) it is the only mass spectrometry imaging technology that can analyze vacuum incompatible samples such as living bacterial and cell colonies. Due to this unique capability, LAESI can be used to analyze a bacterial colony and then that colony can be re-incubated and analyzed at a later time, enabling biodynamics studies on living samples for the first time ever. Figure 6 shows a LAESI mass spec image of bacterial colony.

Figure 6: LASEI Three-Dimensional Ion Map Image of a Live Bacterial Colony Showing the Spatial Distribution of an Antibiotic Molecule (Green) and a Biomolecule Produced by the Bacterial Cells (Orange)

Source: Company reports

LAESI technology enables the direct identification of proteins, lipids and metabolites in tissue, cells and biofluids, such as serum and urine, without any sample preparation prior to analysis. The elimination of sample preparation allows for the sample to be analyzed without the possible contamination, bias or sample loss that occurs with other techniques. LAESI then can display the data obtained by mass spectrometry analysis combined with actual images of the tissue and cell samples. Thus, mass spectrometry data can be evaluated in the context of the biology of the sample, this allows the integration of mass spectrometry data with current pathology and microscopic imaging techniques. Data is available in seconds to minutes, allowing rapid time to results and the capacity to analyze thousands of samples in a single shift. As an example, a researcher testing a new drug's effects on living cells can analyze changes in the cells' metabolism across a specific time course, thereby almost immediately obtaining data as to the activity of the new drug.

In LAESI, the chemical identity of biomarkers or other biomolecules present, for example in a tissue, is investigated as a function of spatial distribution. This paradigm allows accurate distribution profiling of chemical species that may help to understand pathologies or metabolic processes present in the specimen. LAESI has the potential to revolutionize biological investigation using objective chemical data by presenting the distribution of specific molecular structure in situ.

LAESI has the potential to revolutionize biological investigation using objective chemical data by presenting the distribution of specific molecular structure in situ

LAESI Procedure

LAESI produces ions for mass spec analysis under normal atmospheric conditions for samples containing water. A small portion of the sample is ablated into the gas phase by a short (5 ns), mid-IR (2,940 nm) laser pulse that is

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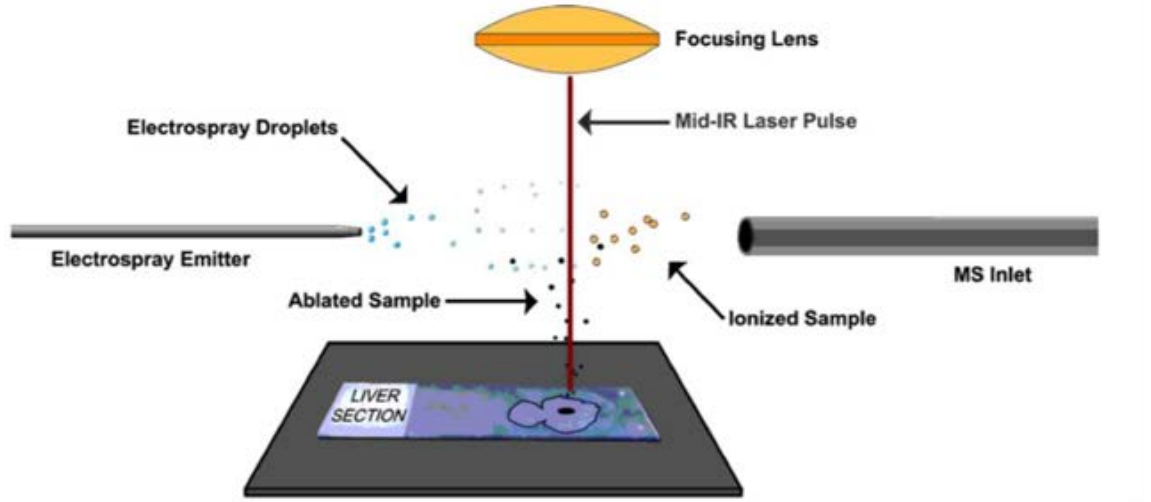
tuned to the strong absorption line of liquid water. First, the laser produces a small hemispherical plume over the sample without ionization. The plume expands until it collapses into the sample due to the pressure exerted by the atmosphere. At this point, a jet of material is ejected from the sample surface. This secondary material ejected from the sample contains very few, if any ions, therefore an ESI source is located above the sample for post-ablation ionization. The jet of ablated material is intersected and ionized by a spray plume from the ESI source located above the sample. The ionized molecules are then swept into the mass spectrometer for analysis. Because an ESI source is used for ionization, the LAESI mass spectra are similar to traditional ESI spectra, which can exhibit multiply charged analyte peaks, and extend the effective mass range of detection to biomolecules >100,000 Da in size.

Figure 7: LAESI Illustration



Source: Company reports

Limitations of Current Mass Spectrometry Products

Required Sample Preparation: Sample preparation for mass spectrometry is tedious, time consuming and results in operating complexity. Separation techniques such as gas chromatography (GC), liquid chromatography (GC) and others have been developed to facilitate sample preparation for mass spectrometry but current techniques require an experienced and highly skilled user. As a result, mass spectrometry has largely been limited to use by analytical chemists and has failed to be adopted by other end users lacking this particular expertise.

Destruction of Sample: Mass spectrometry requires that a sample be homogenized, purified in certain instances, or have additional chemicals introduced to it in order to be analyzed by a mass spectrometer. Homogenizing a sample means that molecules (ions) can be detected and quantified but their location in the original sample cannot be identified. Purification and adding chemicals result in the introduction of variation based on respective user techniques and protocols and could result in reproducibility issues. As a result of the sample being destroyed, further analysis after mass spectrometry analysis is

not possible, which can cause users not to analyze samples that they perceive to have future value.

Limited Number of Compatible Samples: In order for a mass spectrometry analysis to occur, a sample must be in the gas phase and have a charge. Therefore, the number of sample types that can be directly analyzed via a mass spectrometer is limited and can exclude biological samples such as tumor tissue biopsies, animal organ tissue and whole body animal tissue sections (mouse and rat). Also, mass spectrometry analysis occurs under vacuum conditions and therefore cannot analyze living cell samples such as a bacterial colony or cell culture because the sample will be immediately destroyed by vacuum conditions. Living cell samples are used extensively in pharmaceutical research and biomarker discovery.

No Imaging Capability: Mass spectrometers identify molecules based on their mass-to-charge ratio (m/z) and display each molecule identified in a sample on a mass spectra (mass spectrum). A mass spec result is displayed as an X/Y graph with the X-axis showing molecules based on their m/z and the Y-axis showing their relative intensity (amount of molecule present). Each molecule is represented as a bar or "peak" on the X-axis with the height of the peak being correlated to the abundance of that particular molecule. Mass spectra can be very complex data sets that are difficult to interpret and can have limited relevance to biology-centric applications. Molecular imaging techniques such as PET, SPECT and CT have become commonplace in pharmaceutical research and biomarker discovery due to their ability to display molecules in relation to biologic and anatomic features. Mass spec's inability to perform imaging is considered a major limitation to these markets.

Mass spec's inability to perform imaging is considered a major limitation

Benefits of the LAESI Technology

Rapid Time to Results: The time between sample acquisition and analysis can often be measured in seconds. This provides the capacity to analyze thousands of samples in a single work period. Due to the elimination of sample preparation and the rapid nature of LAESI, improvements in analysis speed as much as 10x are possible. This factor makes LAESI attractive to users that utilized mass spectrometry for high-throughput applications. Also, LAESI makes mass spectrometers more efficient, improves laboratory efficiencies and introduces costs savings due to time saved.

No Sample Preparation Required: Protea's LAESI technology analyzes samples directly without separating the techniques and protocols to obtain mass spectrometry data. Virtually all sample types can be inserted directly into the LAESI DP-1000 instrument where they are ablated (put into gas phase), ionized (charged) and sent into the mass spectrometer, in a process taking fractions of a second. Also, as the LAESI DP-1000 has a user-friendly interface that eliminates the operation complexity of traditional mass spectrometry, a wide array of users beyond analytical chemists can generate mass spectrometry data on their samples. By eliminating sample preparation, the biological sample can be analyzed without the possible contamination, bias or sample loss that occurs with the current techniques, which require the introduction of chemicals, or the destruction of the sample itself (see below), in order to enable analysis.

No Sample Destruction: Protea's LAESI technology does not require a sample to be homogenized, purified and does not require the introduction of any

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chemicals for mass spec analysis to occur. Because the sample is not destroyed, the identification of a molecule's location in a sample is made possible via LAESI. Also, variability is eliminated as a result of LAESI and tests can be reproduced as the sample is preserved.

Small Sample Consumption: The small sample size utilized in LAESI analysis means that the source sample is still available for additional investigation.

Various Types of Samples Can be Used. Samples can be solid, liquid, amorphous or combinations of these formats, including tissues, cells, and biofluids (blood, urine, CSF et. al.). LAESI enables the first direct mass spectrometric analysis of living cells and cell colonies. LAESI is able to analyze virtually all sample types because of its novel design and the fact that it operates at ambient pressure (i.e. not a vacuum). As a result, tumor tissue biopsies, animal organ tissue and whole body animal tissue sections can all be analyzed. Also, living cell sample such as bacterial colonies and cell cultures can be directly analyzed. LAESI is able to analyze the largest number of sample types of any of the current mass spec technologies.

Impressive Imaging Ability: The LAESI DP-1000 system enables two-dimensional and three-dimensional imaging via mass spectrometry. LAESI displays the distribution of molecules in a given sample. LAESI is the only technology that can facilitate this capability for mass spectrometry in tissue sections (animal and human tissue), living cell samples and other sample types. LAESI enables spatial analysis with 2D and 3D imaging capabilities. The identification of biomolecules can be displayed and localized in visual images of the tissue or cells, allowing the researcher to actually see the location of specific biomolecules in cells. LAESI is compatible with a broad range of biomolecules, from small metabolites to large proteins. LAESI can identify cell metabolites that serve as markers to identify virally-infected cells, in minutes.

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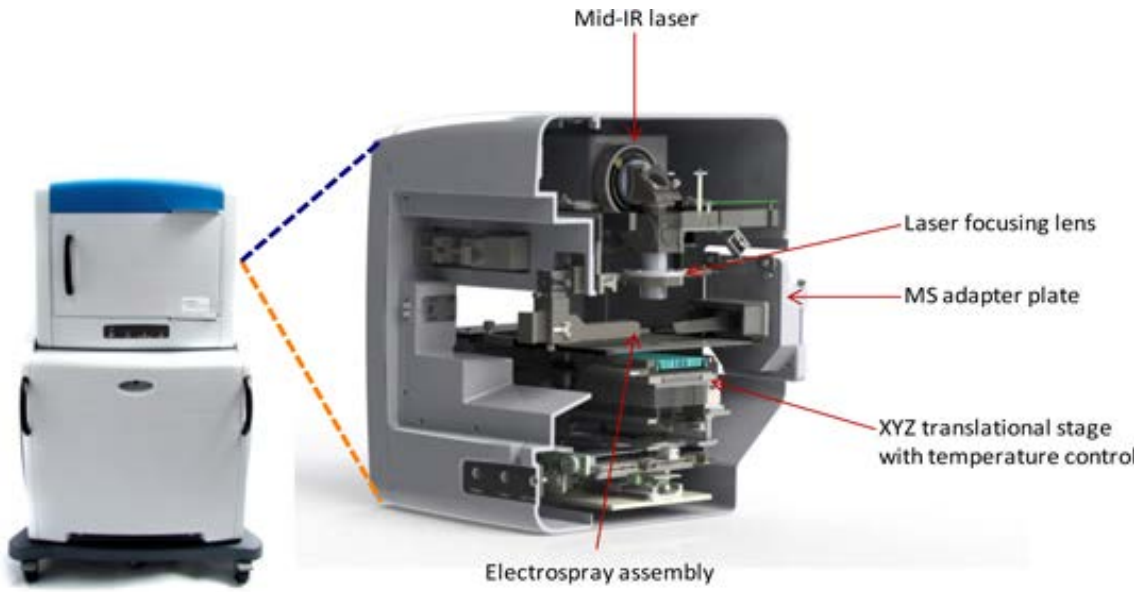
The LAESI DP-1000

The LAESI DP-1000 directly ionizes samples in a two-step process: laser ablation and electrospray ionization (ESI). The process begins when the sample is ablated by a short, mid-IR laser pulse that is tuned to the strong absorption line of liquid water (2940 nm). This laser pulse creates a small plume of non-ionized material. As the plume collapses, a secondary jet of material is ejected from the sample surface and into the ESI stream where it is ionized. The ionized material is then vacuumed into the mass spectrometer for analysis. Thus, the LAESI DP-1000 combines laser resolution capabilities with electrospray ionization benefits.

Figure 8: LAESI DP-1000 Instrument

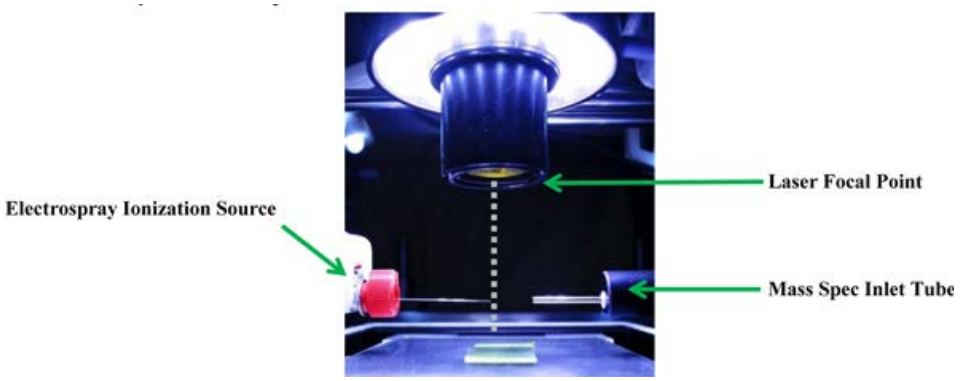


Source: Company reports

The LAESI DP-1000 directly ionizes a sample as it exists in nature, providing information on the native chemistry

The LAESI DP-1000 open well plate imaging facilitates high-throughput biological fluid analysis. Biological fluids can be directly analyzed for compound detection or quantitative studies without any upstream sample preparation. Samples can be analyzed in a variety of standard well plate sizes, with ultra-fast programmable stage movement to increase laboratory productivity and overall sample processing capabilities. Traditional methods of sample analysis require extensive and time consuming sample preparation. The LAESI DP-1000 changes this paradigm by directly ionizing a sample as it exists in nature, providing information on the native chemistry of the sample as well as distribution profiling of molecules.

Figure 9: Key LAESI Components



Source: Company reports

LAESI is the only mass spectrometry imaging technology that performs a volumetric sampling

LAESI is the only mass spectrometry imaging technology that performs a volumetric sampling. All other mass spectrometry imaging technologies perform surface analysis or desorption whereby they are only extracting small amounts of molecular information. The nature of the LAESI DP-1000 mid-IR laser enables it to penetrate samples in the Z-plane enabling 3D analysis and imaging. In a 2009 article in the Journal of Analytical Chemistry, scientists from the Department of Chemistry at George Washington University found that 3D imaging of molecular distributions by LAESI offers insight into the correlation between biochemical processes and the spatial organization of a biological tissue. Simultaneous identification of diverse molecules is a virtue of mass spectrometry that in combination with ambient ion sources enables the atmospheric pressure investigation of biomolecular distributions and processes.

The LAESI DP-1000 can analyze and image both human and animal tissue. Datasets are automatically generated, and are available in minutes, depending on the complexity of the analysis. Figure 10 shows a LAESI mass spec image of two molecules shown simultaneously in a Z x Z mouse pup section. This analysis took approximately 180 minutes.

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Figure 10: LAESI 2 dimensional map image of two molecules shown simultaneously in Z x Z mouse pup section

Source: Company reports

The company offers the LAESI DP-1000 instrument as well as software packages developed by the company (LAESI desktop software and ProteaPlot). Protea's software facilitates operating the instrument and the storage and display of datasets in a user friendly, intuitive interface environment. The LAESI and ProteaPlot software include LAESI data mining and analytic tools to search for new, disease-specific biomarkers, and to elucidate disease-specific biomolecular pathways. In addition, it provides an expanding line of LAESI consumables.

LAESI DP-1000 is currently compatible with 3,000 mass spectrometers worldwide from Waters Corp. and ThermoFisher Scientific

Protea has done a thorough analysis of the installed mass spectrometers that the LAESI DP-1000 is currently compatible with. Based on information that the company has compiled, it believes that the LAESI DP-1000 is currently compatible with 3,000 mass spectrometers worldwide from Waters Corp. and Thermo Fisher Scientific. Protea intends to work towards making the LAESI DP-1000 compatible with a larger number of mass spectrometers through integration with other mass spectrometry vendors such as Danaher's AB Sciex unit, Bruker and Agilent. Protea is building a direct sales force to market and sell the instrument to existing mass spectrometer users and those seeking to acquire compatible high-resolution mass spectrometers. In addition the company will seek to execute co-marketing agreements with select mass spectrometry manufacturers and vendors. In March 2012, Protea executed a non-exclusive co-marketing agreement with Waters Corp. and may seek to execute additional agreements of similar nature. Also, Protea is expected to execute agreements with select international dealers.

In March 2012, Protea executed a non-exclusive co-marketing agreement with Waters Corp

Development efforts are expected to be undertaken to develop LAESI DP-1000 specific consumable products that will bring a recurring revenue stream to the instrument platform

The Bioanalytical Consumable Products group encompasses consumable products used in bioanalytical mass spectrometry, including a family of proprietary reagents that can rapidly remove proteins out of biological samples and into liquid phase, preparing them for analysis by mass spectrometry; single use products, including pipette tips and 96 well plates. Specific mass spec applications exist that can benefit from consumable products that improve sensitivity, throughput and comprehensiveness of the mass spec analysis. Development efforts are expected to be undertaken to develop LAESI DP-1000 specific consumable products that will bring a recurring revenue stream to the instrument platform. Consumable products for mass spectrometers will give Protea a deeper visibility into its intended sales channel and will bring a line of

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what could be high-margin revenue. The LAESI DP-1000 generates very large data files that add value to current research and can be saved to add value to future projects. Protea is focused on creating software and analytical tools that enhance the value of the data generated by the LAESI DP-1000. The company envisions creating disease, molecular and applications specific databases and software platforms that enhance the value of these databases that will be forming the Molecular Database Products unit.

Patent Protection

In June 2011, the first LAESI patent (US 7,964,843), which expires on May 21, 2026, was issued for "3D Molecular Imaging by Infrared Laser Ablation Electrospray Ionization Mass Spectrometry." A continuation (CON) patent (US 8,299,429) was issued in 2012 to extend the intellectual property around this foundational patent. A second CON patent has been allowed and is awaiting issuance by the USPTO. Additionally, the USPTO granted allowance for the second LAESI patent (US 8,067,730) in 2011 for "Laser Ablation Electrospray Ionization (LAESI) for Atmospheric Pressure, In Vivo, and Imaging Mass Spectrometry."

Figure 11: IP Portfolio

Patent Number	Claim	Expiration	Status
US 7,964,843	3D Molecular Imaging by Infrared Laser Ablation Electrospray Ionization Mass Spectrometry	2026	Issued
US 8,299,429	To Extend the Intellectual Property Around This Foundational Patent	2026	Issued
US 8,067,730	Laser Ablation Electrospray Ionization (LAESI) for Atmospheric Pressure, In Vivo, and Imaging Mass Spectrometry.	2026	Allowed
US 8,487,244	Laser Ablation Electrospray Ionization (LAESI) for Atmospheric Pressure, In Vivo, and Imaging Mass Spectrometry	2026	Issued
US 8,487,246	Three-Dimensional Molecular Imaging By Infrared Laser Ablation Electrospray Ionization Mass Spectrometry	2026	Issued
	A Second CON Patent Has Been Allowed and is Awaiting Issuance by the USPTO		Pending

Source: Company reports

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Molecular Information Services and Molecular Database Products

Protea has a leading direct molecular imaging commercial laboratory that has eight employees with Ph.D.'s and occupies an 11,000 square foot facility. In 2013, it began offering mass spec imaging services, including two- and three-dimensional biomolecular distribution profiling utilizing LAESI, high throughput biofluid analysis, biodynamic live cell colony monitoring, and biomaterial characterization. LAESI bioanalytical services are available for the rapid identification of both small molecules (e.g. lipids and metabolites) and large molecules (e.g. proteins). The services unit is operated under GLP (Good Laboratory Practices). Protea is the only molecular diagnostics firm to offer tissue mass spec imaging via LAESI technology and it will maintain this exclusivity until the company decides to license out the technology. LAESI can be used to perform mass spec imaging experiments of diverse tissue samples, not only in three dimensions, but also with respect to time. As we mentioned earlier in this report, LAESI has more advantages over other types of mass spec analysis, such as MALDI, for biological tissue samples and it can be preferred by customers when time is an issue for the study of non-biologic tissue samples. LAESI can also be used for process monitoring applications because each individual analysis requires less than 2 seconds to perform. Due to the speed of a LAESI analysis, the technique is amenable to rapid, sensitive, and direct analysis of aqueous samples in 96- and 384-well microplates. These analyses can also be performed on liquid samples, such as biofluids, containing peptides, proteins, metabolites, and other biomarkers for clinical, diagnostic, and discovery workflows. LAESI technology allows high throughput analysis of these sample types and the use of internal standards and calibration curves permit the absolute quantitation of targeted biomolecules. The high throughput that LAESI enables could be of interest for customers for whom time is a factor.

Protea is the only molecular diagnostics firm to offer tissue mass spec imaging via LAESI technology

Biomarkers are biochemical substances or events that indicate a particular biological state. Protea's imaging services allows researchers to submit tissue samples and offers selected areas of interest to be studied. This helps to ensure data generated pertains directly to the cell population of interest with immediately available results. Protea's target markets include direct molecular imagining for preclinical R&D for pharmaceutical and biotechnology companies, as well as, biomarker discovery for academic research, clinical medicine, agricultural biology applications, cosmetics, food testing, and medical device development. Academic biomarker discovery collaboration clients include Memorial Sloan-Kettering Cancer Center, Virginia Commonwealth University, University of Southampton (UK), and Georgetown University. Protea's clients include two "top 5" global pharmaceutical companies, a European biopharmaceutical company, and major cancer research centers. Additionally, the company received a $15 million DARPA contract, in a consortium with George Washington University, Stanford Research Institute and GE Global Research with a goal of reducing time to identify biological and chemical threat agents from one year to 30 days.

The company received a $15 million DARPA contract as part of a consortium with a goal of reducing time to identify biological and chemical threat agents from one year to 30 days

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Protea's management estimates the mass spectrometry molecular imaging market could exceed $1 billion annually. This is based on examinations of various markets including pathology of antibodies, reagents, and sequencing, as well as the traditional mass spectrometry services and indirect molecular imagining markets. We concur with the company's estimate. The worldwide traditional mass spectrometry market is estimated to be approximately $3.6 billion in 2014 according an analysis by TechNavio. The annual potential addressable market for preclinical drug R&D services is $1.5 billion. Incorporating biomarker research into drug development can decrease time to development and capital investments for pharmaceuticals companies resulting in millions of dollars saved. Protea has signed a six-figure contract to discover biomarkers for oncology applications. We also believe that databases developed through the services sector will create additional expertise for Protea as well as decrease future costs to repeat customers and increase margins due to application of existing methods and inferences.

The annual potential addressable market for preclinical drug R&D services is $1.5 billion

Protea is applying LAESI technology to create cell-based biomolecular databases that will be specific to disease states and allow the analysis and integration of LAESI biomolecular datasets with the sample-related pathology, gene expression and demographic datasets. These databases will form the Molecular Database Products. Protea is developing "high resolution" LAESI technology that will enable the analysis of single cells. We believe LAESI can generate important advances in bioinformatics to help provide time-based, biodynamic datasets for improved disease state assessment and management.

Protea is applying LAESI technology to create cell-based biomolecular databases that will be specific to disease states

In addition to pharmaceutical and biotechnology customers, potential growth areas that could lead to significant expansion in the demand for its mass spectrometry imagining services are dermatological applications, food and beverage testing, forensics, and agricultural biology. Dermatological applications include studying transdermal drug delivery, a non-invasive approach to delivering medications through the surface of the skin. A major hurdle to wider acceptance of the transdermal drug delivery is the necessary molecular properties of drugs that are suitable for absorption through the skin barrier without modification. The absorption process requires the drug passing through the stratum corneum, a highly lipophilic membrane, until it reaches the capillary bed of the dermis layer and into systemic circulation. Imaging services could prove critical in early proof of concept for transdermal drugs as well as enhanced understanding of method of delivery in the development stage. In the food and beverage industry, increased FDA packaging and food and beverage content requirements have created additional market opportunities as companies outsource their imagining to ensure accurate testing and compliance.

The company applies LAESI technology to create comprehensive, tissue and cell-based molecular information databases that will be specific to disease states and allow the integration of LAESI molecular datasets with related pathology, gene expression and demographic datasets, with the purpose of improving human disease state detection, assessment and management. The company develops scientific collaborations with key academic centers to jointly discover and develop new therapeutic targets and disease specific biomarkers. The company's initial focus is the development of molecular information databases in the fields of oncology and neurodegenerative disease.

The company develops scientific collaborations with key academic centers to jointly discover and develop new therapeutic targets and disease specific biomarkers

On April 30, 2014, Protea announced it began a collaborative research initiative with the Memorial Sloan-Kettering Cancer Center (MSK) and the Dana-Farber Cancer Institute (Dana-Farber) in Boston that uses Protea's next generation

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LAESI direct molecular imaging technology to analyze cancer cells. The initial focus is early stage lung adenocarcinoma. The studies will utilize LAESI technology to generate molecular data profiles of cancer cells in tissue and biofluids to improve the comprehension of a cancer's origin. LAESI can generate large molecular data profiles of cancer cells in their native state. The principal investigators are Robert J. Downey, M.D. FACS (a noted chest surgeon specializing primarily in lung cancer and researcher investigating whether adult cancers arise from the stem cells) and Andre Moreira, M.D., Ph.D. (whose areas of interest are cytopathology and pulmonary pathology) at MSK and Dana-Farber's Franziska Michor, Ph.D. (Associate Professor Department of Biostatistics and Computational Biology, Dana-Farber Cancer Institute, Department of Biostatistics, Harvard School of Public Health). We anticipate other studies utilizing LAESI for direct molecular profiling in other tissue sample types could follow. We believe that as LAESI provides comprehensive molecular profiling of tumors rapidly and directly, its use will become more prominent in research laboratories.

The rapid generation of the large molecular datasets can extend and add value to other technologies, including 3D tissue printing, biomarker discovery and synthetic biologicals

Protea is constantly looking for new research models where it can utilize LAESI to obtain better data from interesting research models than could be done with traditional technologies. The rapid generation of the large molecular datasets can extend and add value to other technologies, including 3D tissue printing, biomarker discovery and synthetic biologicals. Protea is collaborating with other platform companies, utilizing these platforms, to apply LAESI to generate large molecular profiles of their tissue samples, thereby extending the capabilities of their platforms. So as more companies, like Organovo, with its 3D printed livers, and Champions Oncology, with its patient derived tumor models, emerge, it potentially expands the number of applications for LAESI.

Protea plans to continue hiring staff for the services division and expanding its sales force. It currently has 4 field sales representatives and we expect the company will expand to about a dozen reps by 2018. Scientific staff additions are also anticipated. In addition, Protea has made additional capital expenditures for equipment, including the recent purchase of a Bruker Ultraflex MALDI, to improve its service offerings and capabilities for over $700,000. The company also has AB Sciex, Thermo Fisher and Waters mass spectrometers. We believe service revenue will grow to $1.1 million in 2014 with significant growth in 2015 and beyond and that Protea's West Virginia facilities have the capacity to meet all projected services demand. Greg Kilby Ph.D. has been Protea's Chief Bioanalytics Officer since October 2013 and oversees the services business. Dr. Kilby has held leadership positions at Pfizer, Agilent and most recently, Thermo Fisher Scientific. Protea has recently made key hires of individuals from the Vanderbilt University Caprioli Laboratory, a leading research institution in the field of mass spectrometry, including Erin Seeley Ph.D. and Peggi Angel Ph.D. Dr. Seeley has specific expertise in tissue imagining and is a nationally recognized leader in mass spectrometry, which we believe will be instrumental in the expansion of dermatology services and applications in transdermal drug delivery. In an effort to expand the services business sales effort, Protea hired David Halverson in June 2013. Mr. Halverson brings over 20 years of experience with international Contract Research Organizations.

According to management, the typical first contract for services ranges from $20,000 to $40,000. Larger customers may have an initial contract of $100,000, moving to $250,000 through contract escalation and repeat service utilization. In addition, once established as an official vendor, Protea can be added to company's master services agreements making them visible to entire

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organizations as an option for biomarker imaging. We estimate Protea's Services unit will generate sales of $1.1 million in 2014 and $2.9 million in 2015. We expect the Services unit sales will reach $47.3 million by 2020.

In November 2011, Quintiles Transnational Holdings, Inc. acquired Advion BioServices, Inc., for $54.9 million to enhance its biomarker and advanced testing capabilities by offering services such as biomarker discovery and testing, molecular screening, and drug discovery and metabolism analysis. Quintiles is the only fully integrated biopharmaceutical services company offering clinical, commercial, consulting and capital solutions worldwide with a network of more than 28,000 engaged professionals in approximately 100 countries. At the time, Advion BioServices had more than 180 employees at facilities in New York, Virginia, and Indianapolis. Quintiles's strong commitment to grow and expand its bioanalytical services globally was a key driver for the acquisition. Quintiles management stated that Advion's ability to help companies gather early-stage data and gain insights aimed at reducing the risk of failure in expensive later-stage trials. Following the acquisition, Advion maintained its business of developing purpose-built mass spectrometers, nanoelectrospray ionization sources, and flow-chemistry synthesis systems and consumables. We believe Protea will continue to grow its services business but acknowledge that this unit might be an attractive target for larger biopharmaceutical services companies.

We believe Protea will continue to grow its services business but acknowledge that this unit might be an attractive target for larger biopharmaceutical services companies

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Market Overview

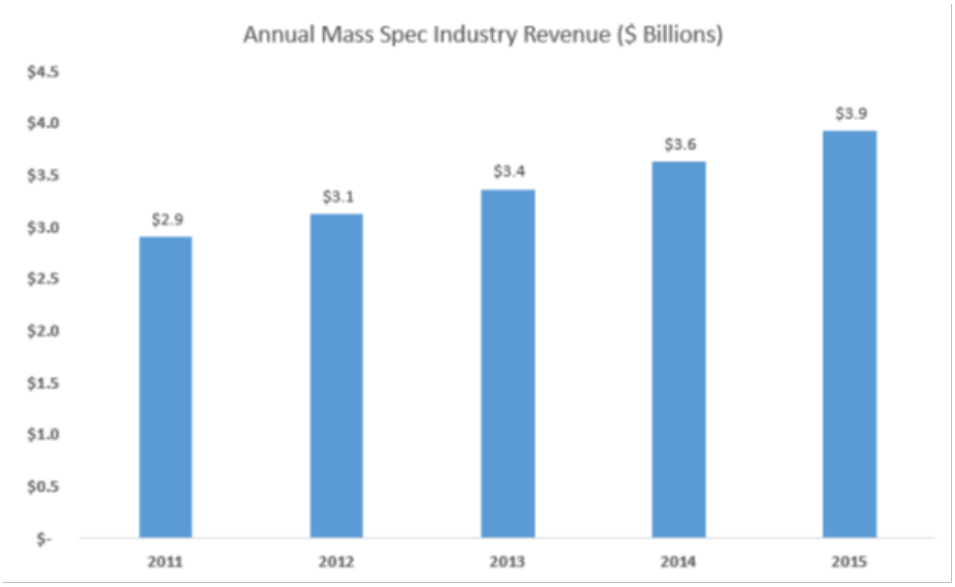
Mass Spectrometry Instruments

Protea has two major business lines: mass spectrometry instruments & consumables products and analytical services. The instruments & consumables products are serving the bioanalytical market and in particular laboratories that are using mass spectrometry as their core technology. The company believes that its strong IP position allows it to offer unique products aimed to improve the efficiency and capabilities of analytical laboratories in drug discovery and development. Protea's LAESI DP-1000 system, provides a chemical mapping of biological samples, greatly enhancing the research and development process of a drug.

The global mass spec instrument market was approximately $3.4 billion in 2013 and it is expected to reach $3.9 billion by 2015

According to the TechNavio Report, the global mass spec instrument market was approximately $3.4 billion in 2013 and it is expected to reach $3.9 billion by 2015, growing at a CAGR of 7.8% from 2011 through 2015 (Figure 12). The U.S. accounts for about 40% of the global mass spectrometry instrument market representing approximately $1.3 billion. Europe accounts for about 30% of the global market, the Asia-Pacific region accounts for about 23% of the global market with the rest of the world accounting for the remaining 7%. As seen in Figure 13, the mass spectrometry instrument market can be segmented into three major sub segments; Biopharmaceuticals, (40% of the global market), Industrial (31%) and Academia (29%).

Figure 12: Global Mass Spectrometry Instrument Industry Market Size 2011 – 2015E ($ billions)



Source: TechNavio Analysis, Global Mass Spectrometry Market 2011 – 2015, Company reports

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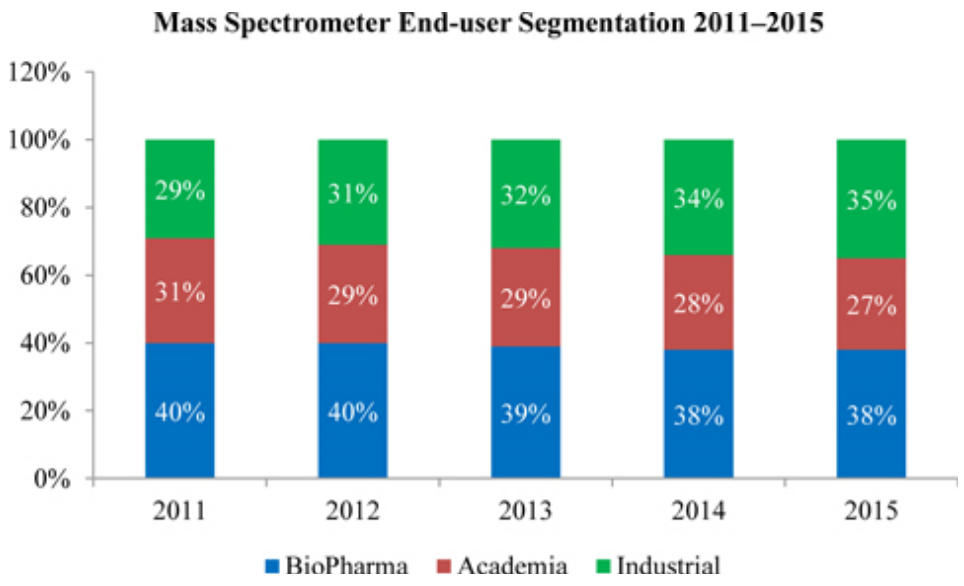
Figure 13: Mass Spectrometer End-user Segmentation (2011–2015)



Source: TechNavio Analysis, Global Mass Spectrometry Market 2011 – 2015, Company reports

In 2011, it was estimated that there was a total installed base of 5,700 mass spectrometers in the large pharmaceutical companies sub-segment

The cost of a mass spectrometer can range from $30,000 to $2.5 million and the life span of a mass spectrometer can be anywhere from five to seven years. As a result of the combination of the high cost and the long life span, the probability of replacing a mass spectrometer within the five-year period is very low. In 2011, it was estimated that there was a total installed base of 5,700 mass spectrometers in the large pharmaceutical companies sub-segment. The CAGR for the installed base for this sub-segment is expected to be 3.7% during the period of 2011–2015, according to a global mass spectrometry report by TechNavio. In 2011, a total of 760 mass spectrometers at a cost of $270.8 million were estimated to have been installed (new mass spectrometer systems and replaced mass spectrometer systems) in this sub-segment. The average selling price (ASP) of a mass spectrometer in this sub-segment was found to be approximately $280,000 and it is expected to increase during the forecast period at a CAGR of 2.6%. Importantly, it is forecast that in the coming years, mass spectrometers will be equipped with higher resolving power and better functionalities. Revenue from large pharmaceutical companies is expected to grow at a CAGR of 5.4% from 2011 through 2015. Replacement sales take place as a result of the previous model of a mass spectrometer being outdated or the need for higher resolving power for specific sample analysis. It is estimated that 96.6% of this market is replacement sales. The CROs and biotech companies sub-segments have been adopting mass spectrometer systems at a much faster rate than the other sub-segments. However, the adoption of high-resolution mass spectrometers is not high in the two sub-segments mentioned above since ion traps or triple quad LC-mass spectrometry platforms are typically used in development in these sub-segments. The vast majority of mass spectrometers that are sold in these sub-segments are primarily from Danaher Corp.

Most of the CROs have not significantly increased their installed base, but they have upgraded their outdated equipment, which offers an opportunity for

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LAESI. The biotech sub-segment is estimated to have an equal number of mass spectrometers as compared to the large pharmaceutical companies, especially high-end instruments.

In 2011, the biopharmaceutical segment was the largest mass spectrometry market based on revenues, due to the fact that this segment consists of a number of sub-segments which require high-cost mass spectrometers for a variety of applications. Moreover, with increasing focus on testing and research in the last decade, the demand for mass spectrometers had increased during this period. The key customers of mass spectrometers in this segment have a higher budget for research and testing purposes, as these purposes are essential for the final end-product of the respective customer.

The academia segment comprises universities, government research centers, and any educational center that may use mass spectrometers for academic and research purposes. The revenue from sales of mass spectrometers for the academic segment is highly dependent on the research budget of the respective institutions and the availability of stimulus packages that help in increasing an institution's research capabilities. For instance, for academic institutions in the US, the funding for the purchase of high-end equipment such as mass spectrometers comes from the High-End Instruments Grant Program S-10. On average, until about five years ago, a university would have had around two to three high-end resolution systems. Today, a university has an average of around five to ten high-end resolution systems. The academia segment registered a moderate contribution to the revenue generated from sales of mass spectrometers in 2011. Educational institutions have been focusing on increasing their research capabilities in recent years, and hence the availability of the latest equipment for research is imperative. Furthermore, educational institutions are also rated based on the quantity and, more importantly, the quality of the equipment that is available for their students.

The high throughput capability of LAESI gives this technology an advantage in the industrial segment, in our opinion

The industrial segment consists of various sub-segments, some of which are: food and beverage testing, petrochemical testing, environmental testing, forensics, cosmetics, biodefense, agriculture, and clinical testing. The high throughput capability of LAESI gives this technology an advantage in the industrial segment, in our opinion. The industrial segment has been registering the highest growth in recent years, and a CAGR of 13% is expected during the forecast period. There has been slow growth in the adoption of mass spectrometers for clinical reference laboratories. However, the number of tests performed in such laboratories has increased considerably in the last ten years. There are a number of regulatory protocols which define the usage of mass spectrometry in clinical research. Several years ago, the FDA issued draft guidance on research-use-only and investigational-use-only laboratories for in vitro diagnostic products that states device manufacturers such as mass spectrometer vendors are prohibited from selling such products to laboratories where the products are used for clinical diagnostics. As a result of such regulations and guidance, the mass spectrometer vendors have ensured that their products meet the regulatory standards of various institutions for clinical laboratories. Some companies have also decided to sell their devices under clinical laboratory improvement amendments protocols. Protea can sell its devices to clinical labs. The industrial segment contributed the least revenue to the global spectrometry market of all segments in 2011. However, it is expected to be one of the fastest-growing segments for this market during the forecast period because, as me mentioned above, various regulations for clinical research

Protea can sell its devices to clinical labs

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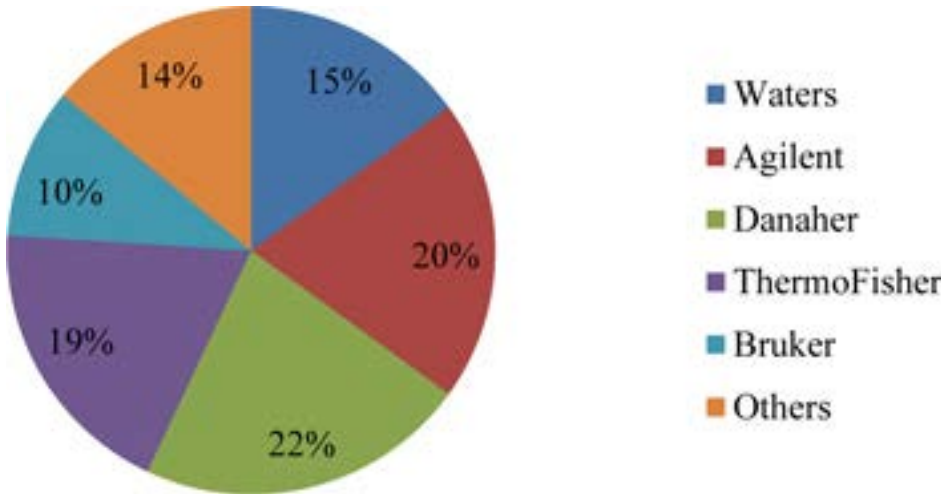
are providing sufficient reasons for the purchase of mass spectrometers in this segment.

The global mass spectrometry market is dominated by five key vendors: Agilent Technologies Inc., Bruker Corp., Danaher Corp., Thermo Fisher Scientific Inc. and Waters Corp. These companies are also involved in the sale of other research equipment. Overall, the top five players contributed close to 85% of the total revenue generated in the global mass spectrometry market in 2011. Almost all these companies witnessed rapid growth in their respective revenue from mass spectrometers through the launch of several new products in 2010 and 2011. The estimated 2011 global market shares of the mass spectrometer vendors according to TechNavio Analysis are shown below.

Figure 14: Market Shares by Vendor



Source: TechNavio Analysis, Global Mass Spectrometry Market 2011 – 2015, Company reports

Protea's LAESI DP-1000 is currently compatible with mass specs from Waters and Thermo Fisher Scientific. The company believes that the LAESI DP-1000 is currently compatible with 3,000 mass spectrometers worldwide from those two companies. Protea is working towards making the LAESI DP-1000 compatible with mass spectrometers such as Danaher's AB Sciex unit, Bruker and Agilent and could address 80% - 85% of the market later this decade.

Protea is working towards making the LAESI DP-1000 compatible with mass spectrometers that could address 80% - 85% of the market later this decade

Competition

There are several different techniques in mass spec imaging, each of which have unique characteristics including spot size resolution, mass range, limit of detection and dynamic range. As such, each technique has specific advantages, limitations and addressable applications. Matrix-assisted laser desorption/ionization (MALDI) is a soft ionization technique used in mass spectrometry, allowing the analysis of biomolecules (biopolymers such as DNA, proteins, peptides and sugars) and large organic molecules (such as polymers, dendrimers and other macromolecules), which tend to be fragile and fragment when ionized by more conventional ionization methods. It is similar in character to electrospray ionization (ESI) in that both techniques are relatively soft ways

of obtaining large ions in the gas phase, though MALDI produces far fewer multi-charged ions. MALDI is a two-step process. First, desorption is triggered by a UV laser beam. Matrix material heavily absorbs UV laser light, leading to the ablation of the upper layer (~1 μm) of the matrix material. The hot plume produced during ablation contains many species: neutral and ionized matrix molecules, protonated and deprotonated matrix molecules, matrix clusters and nanodroplets. Second, the analyte molecules are ionized in the hot plume. Ablated species may participate in the ionization of analyte, though the mechanism of MALDI is still debated. Several companies including Agilent, Bruker, Danaher, JEOL, Shimadzu, Thermo Fisher and Waters offer MALDI. As we mentioned numerous times in this report, Protea is the only company that offers LAESI. Other competitive technologies are DESI, SIMS, DART and LESA, though none are used as commonly as MALDI.

MALDI was an integral technology development that lead to the integration of mass spec imaging for biological applications. According to the *SDI 2012 Industry Report*, it is estimated that the annual market for MALDI instrumentation was almost $300 million in 2011, up from $275 million in 2010 and $256 million in 2009. The *SDI 2012 Industry Report* estimates MALDI sales will reach $356 million, implying a 2011-2014 CAGR of 6.8%. We believe LAESI has significant competitive strengths with respect to MALDI. Figure 15 below compares MALDI and LAESI.

Figure 15: Comparison between LAESI and MALDI

Technology	Mass Spectrometry With LAESI	Mass Spectrometry with MALDI
Imaging Capability	☑	☑
No Sample Preparation	☑	☒
Rapid Results	☑	☒
Sample in Native Form	☑	☒
Vacuum Incompatible Samples (i.e. bacterial colony)	☑	☒
Ease of Use	☑	☒

Source: Company reports

We expect LAESI sales will ultimately exceed MALDI sales, however, since only one company, Protea, sells LAESI versus the several major companies listed above that sell MALDI, we believe the revenue ramp up of LAESI sales will be somewhat slower than MALDI. MALDI systems sell for $100,000 - $150,000. The list price for LAESI is $175,000.

Protea markets its products and services worldwide, utilizing a combination of field sales, distributors, in-house sales support and web-based marketing. The company attends exhibitions in the U.S. and Europe to present its products. The company employs six direct sales and marketing representatives in the U.S., two on the Instruments side and four on the Services side. In Europe and Asia, the company employs distributors who purchase the company's products and resell them to customers in their territory. The company targets academic institutions, Biopharma, AgBio and industrial labs. Seven LAESI systems are installed today

in U.S. and Europe. In March 2012, the company executed a non-exclusive co-marketing agreement with Waters Corp. and may seek to execute additional agreements of similar nature. We project Protea's LAESI sales will grow from $1.5 million in 2014 to $3.3 million in 2015 and $54.1 million by 2020.

Protea's Services Unit

A portfolio of mass spectrometry imaging services composes the second business line. Protea is building a direct sales force to market and sell the services to pharmaceutical companies, academic/clinical research laboratories and other industrial/chemical companies that are interested in Protea's mass spectrometry imaging capabilities and expertise. The company leverages its unique technologies to offer complete support and innovative analytical approaches to researchers looking to study bio-dynamics of drugs, their metabolites, or specific molecules indicative of a diseased condition. Results of these services are used by pharmaceutical companies for the characterization of a drug, or by research institutes to advance their knowledge of a specific disease or condition. Protea commenced its molecular information services in 4Q13.

Protea commenced its molecular information services in 4Q13

Protea's Information Services is focused on direct molecular imaging. It is the only commercial laboratory we are aware of that offers tissue mass spectrometry imaging. The global bioanalytics market consists of products and services used to analyze and identify biomolecules that are the products of living cells and life forms. These include proteins, lipids, metabolites and other classes of biomolecules. In addition to human pharmaceuticals and diagnostics, the bioanalytics market includes, among others, the fields of environmental science, forensics, oceanography, cosmetics, agriculture and biodefense.

Protea's Information Services is focused on direct molecular imaging. It is the only commercial laboratory we are aware of that offers tissue mass spectrometry imaging

LAESI products and services are positioned in the two largest global bioanalytics market segments: preclinical drug research is a market segment valued at an estimated $20 billion, and biomarker discovery is a market segment valued at an estimated at $13 billion according to the *SDI 12 Global Analytical Report October 2012* and at $17.4 billion according to R&D Market Research. Preclinical pharmaceutical research refers to the discovery and testing of new candidate therapeutics prior to their use in human clinical trials. For each 5,000-10,000 preclinical drug candidates, only five enter human clinical trials. Thus, there is a great need to obtain better datasets faster to identify the most promising candidates.

LAESI products and services are positioned in the two largest global bioanalytics market segments

Biomarkers are specific biomolecules often measured and evaluated to examine normal biological processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention. Biomarkers are used in many scientific fields. Biomarker discovery is useful for the development of new prognostic and diagnostic tests, as well as in the emerging field of personalized medicine, where biomarkers can identify those patients who will respond well to certain therapies. In human disease research biomarkers are used to identify and validate biomolecules that are associated with the onset and progression of a specific disease. These biomarkers can be used to better identify patient subgroups for more precise selection of optimal treatment, as well as to guide new pharmaceutical development for specific patient subgroups. The leading indication for biomarker research and product development in 2011 was cancer, accounting for 37.5% of revenues. Biomarkers have been used in the diagnosis of certain types of cancer for many years and a number of biomarker diagnostics

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are available for leading indications, such as prostate, breast and colorectal cancer.

The U.S. cancer biomarker testing market is expected to grow from $7.9 billion in 2011 to $11.5 billion by 2017

Developed nations dominated the biomarkers market in 2011, with the U.S. accounting for 60% of total biomarker revenues. The U.S. cancer biomarker testing market is expected to grow from $7.9 billion in 2011 to $11.5 billion by 2017. The molecular-based cancer biomarker testing segment, including single-mutation companion diagnostics, multiplexed array, and other genomic analysis, were only 4% of total market revenues in 2011, but this will likely reach 9.4% by 2017, growing at 22.9% annually (*Frost & Sullivan Analysis of the U.S. Cancer Biomarker Testing Market, June 2012*). BBC Research in its market research report entitled "Biomarkers: Technologies and Global Markets" estimated that biomarker discovery is a $13 billion annual worldwide market with $4.7 billion annually spent on molecular imaging.

Major pharmaceutical companies are showing increasing interest in the biomarkers sector. Between June 2011 and June 2012, six of the top ten pharmaceutical companies signed licensing and development deals related to biomarkers. The growth of the bioanalytics market sector can be attributed in large part to the completion of the mapping of the human genome, the importance of the analysis and characterization of specific proteins to the development and production processes of therapeutic proteins, and the increasing interest in the discovery and identification of other classes of biomolecules that are produced by living cells, including metabolomics (the study of the small molecules which are the products of chemical reactions in cells) and also lipidomics (a subset of metabolites, lipids are produced for the purpose of energy transfer and storage within cells). PhARMA (the Biopharmaceutical Research Industry group) estimates that $15 billion in 2012 was spent by its members on preclinical research including target validation and lead optimization.

We believe there is great potential for future growth in the biomarkers market. Opportunities exist for companies looking to use biomarkers in drug development, manufacture diagnostics and research technologies, and for CROs looking to expand the services they offer.

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Financial Assumptions

In December 2008, Protea entered into an Exclusive License Agreement (amended on February 22, 2010) with George Washington University (GWU) for technology developed in the laboratory of Akos Vertes Ph.D., Professor of Chemistry, Professor of Biochemistry & Molecular Biology, Founder and Co-Director of the W.M. Keck Institute for Proteomics Technology and Applications, the Department of Chemistry. Dr. Vertes is a science advisor to the company. Under the terms of the license agreement, Protea has the exclusive, worldwide, rights to commercialize the technology. The company is obligated to pay expenses for the preparation, filing and prosecution of related patent applications, and license fees equal to $12,500, annual royalties equal to 5% of the net sales of products and processes sold by the company, or an affiliate that utilize the GWU subject technology, after taking into account the annual minimum royalty fees, and 50% of payments received by Protea in connection with any sublicense of the technology under the GWU Agreement. The terms also stipulated that on the first anniversary of either the date on which Protea first sold a product or service utilizing the technology underlying the GWU Agreement or the date on which the company entered into its first sublicense agreement, whichever occurred first, Protea would be required to pay GWU a non-refundable minimum royalty payment equal to $5,000. The first LAESI sale was in March 2013. GWU is entitled to the following non-refundable minimum royalty payments on each subsequent anniversary of the First Sale Date: 2nd Anniversary: $10,000; 3rd Anniversary: $15,000; 4th Anniversary and continuing annually through the expiration or termination of the GWU Agreement: $20,000.

Product revenue is recognized when title passes, which is typically upon shipment of the product. Service revenue is recognized as the service is performed, generally through short-term contracts. The company has sold seven LAESI DP-1000 units to date, including one in April 2014 to Dow Chemical. We believe the sale to Dow is important as it indicates that LAESI technology can provide value to agriculture and chemical companies, two underserved and underpenetrated markets for mass spectrometry.

Protea is investing into new areas for LAESI that should lead to market expansion. It is also working to improve production designs that could lead to a smaller unit size, lower price point, and improved performance. Universal docking is also a priority for the company so that LAESI could be compatible with all mass specs. With engineering improvements and increased volumes, we estimate gross margin can rise from an estimated 72.3% in 2014 to 75.2% in 2015 and 79.8% in 2016. We expect a next generation LAESI unit could be available by 2016. The company currently employs six direct sales and marketing representatives, two on the product side and four in services. We expect another services sales rep will be hired soon and two more sales reps will be hired across both units by the end of the year. Looking further out, we believe the company could have as many as 10-12 sales reps by 2018. We estimate SG&A expense will increase from $8.8 million in 2013 to $10.3

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million in 2014 and $11.3 million in 2015. As we mentioned earlier in this report, manufacturing is now done by a third party and we believe there are no capacity constraints. If needed, we believe manufacturing capacity could be doubled or tripled. We expect the company will continue to expand its capabilities in the services side of the business by purchasing state-of-the-art mass specs annually. We project capital expenses will be $1 million in each of the next two years.

The sale of debt and equity has been supporting the company since its inception. At the end of 1Q14, Protea had $0.3 million of cash on its balance sheet. The company's total current liabilities as of March 31, 2014 were $7.9 million inclusive of $1.1 million of current maturities of long-term debt, $3.0 million in connection with a line of credit, and $1.1 million in loans payable to shareholders. This compares to total current liabilities of $6.2 million and total cash of $1.1 million as of December 31, 2013. According to filings, the company intends to continue to meet operating cash flow requirements by raising additional funds from the sale of equity or debt securities and possibly, developing corporate development partnerships to advance its drug and molecular information technology development activities for sharing the costs of development and commercialization.

During 4Q13, the company raised an aggregate of $5.4 million in connection with a closing of private placement offerings of units consisting of common stock and warrants. The company raised $50,000 from one director in connection with this offering. Also During 4Q13, Protea issued 1) 10% convertible 1-year promissory notes to four accredited investors in an aggregate principal amount equal to $500,000, of which two investors were directors of the company and in the amount of $400,000 and (2) five year warrants to purchase shares of the company’s common stock equal to 37.5% of the number of shares into which each investor’s Note is convertible into, exercisable at $1.10 per share.

As of March 31, 2014, Protea had 65.5 million shares of common stock outstanding. Common share equivalents, consisting of warrants and options outstanding, which could potentially dilute basic earnings per share in the future, and which were excluded from the computation of diluted loss per share, totaled approximately 62.7 million. We used the fully diluted 128.2 million shares outstanding when determining our stock price target.

We estimate that Protea will sell 10 LAESI DP-1000 units in 2014 and generate $2.6 million in sales from both Instrument and Services units. We project instrument sales will grow from $1.5 million in 2014 to $3.3 million in 2015 and $6.8 million in 2016. We estimate Services will generate $1.1 million in revenue in 2014, $2.9 million in 2015 and $5.9 million in 2016. Our EPS estimates are a loss of $0.17 in 2014, a loss of $0.13 in 2015 and a loss of $0.04 in 2016.

Our EPS estimates are a loss of $0.17 in 2014, a loss of $0.13 in 2015 and a loss of $0.04 in 2016

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Management Team

Stephen Turner

Chief Executive Officer and Chairman of the Board

Stephen Turner founded Protea in July 2001 and currently serves as CEO and Chairman. 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.

Edward Hughes

Chief Financial Officer

Edward Hughes has served as CFO 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 the Chicago area. From 1987 to 1998 Mr. Hughes was employed by Rhone Poulenc Rorer from 1987 – 1998. He is currently a Board member of the Pittsburgh Chapter of Financial Executives International.

Matthew Powell, Ph.D.

Director of Research & Development and Chief Science Officer

Matthew Powell serves as 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 he is the inventor of several proprietary bioanalytical technologies in currently used by Protea.

Gregory W. Kilby, Ph.D.

Chief Bioanalytics Officer

Dr. Kilby has been at Protea since October of 2013 and serves as the Chief Bioanalytics Officer. Dr. Kilby has held leadership positions in several fortune 500 companies, leading teams, for over 15 years, at Pfizer, Agilent and most recently, Thermo Fisher Scientific. Dr. Kilby has published and presented his work extensively over this time and is an active member in the American Society for Mass Spectrometry.

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Valuation

We forecast sales will grow from $1.2 million in 2013 to $13.2 million in 2016 and over $100 million by 2020, an impressive revenue CAGR of 88.2% out to 2020

Our price target is $4.50

We are initiating coverage on Protea with a BUY rating and $4.50 price target. We forecast sales will grow from $1.2 million in 2013 to $13.2 million in 2016 and over $100 million by 2020, an impressive revenue CAGR of 88.2% out to 2020.

Our price target of $4.50 is based on 7.0x on the net present value of our revenue estimates. Due to its exponential growth potential, the multiple we use is slightly above the average of comparable companies including Foundation Medicine (a company that provides advanced molecular information that is used in clinical medicine and also by pharmaceutical companies to manage clinical trials) and platform companies in the genomics industry - NanoString Technologies, Fluidigm and Cepheid.

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Risks to Owning the Stock

As with all medical technology companies, many factors can impact operating results including but not limited to changes in government regulations and oversight, product development failures and delays, litigation outcomes, competitive launches, and product recalls. The mass spectrometry molecular imaging market is highly concentrated and competitive. Current and potential competitors have significant resources to aggressively promote their products. Most of these companies have more resources than Protea. Competitors could develop technologies and products that are more effective, easier to use, or less expensive than LAESI as well as utilize existing sales channels to market their products to a wider base of customers. Large competitors in the mass spectrometry market include Agilent Technologies, AB SIEX (Danaher Corp. subsidiary), Bruker, Thermo Scientific, and Waters Corporation. A large majority of the revenue generated in the global mass spectrometry market is concentrated among five key competitors. The company's services unit may require significant future capital expenditures for equipment necessary to remain competitive. In addition, the company's services has competition from multiple sources including DNA sequencing solutions providers, traditional mass spectrometry imaging, and molecular imaging services providers.

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Figure 16: Income Statement

PROTEA BIOSCIENCES GROUP, INC. *Income Statement (000s, except per share data)*	FY 2012 Q1_12 Mar	 Q2_12 Jun	 Q3_12 Sept	 Q4_12 Dec	FY 2013 Q1_13 Mar	 Q2_13 Jun	 Q3_13 Sept	 Q4_13 Dec	FY 2014E Q1_14 Mar	 Q2_14E Jun	 Q3_14E Sept	 Q4_14E Dec	FY_11 Dec	FY_12 Dec	FY_13 Dec	FY_14E Dec	FY_15E Dec	FY_16E Dec
Revenue	**179.494**	**223.963**	**165.538**	**265.3**	**481.6**	**278.0**	**178.5**	**285.4**	**468.1**	**525.0**	**680.0**	**1,050.0**	**713.0**	**834.3**	**1,223.5**	2,723.1	**6,724.0**	**13,161.3**
Operating expenses:																		
Cost of good sold	-	-	-	-	-	-	-	-	-	167.3	238.9	324.0	-	-	-	730.2	1,664.5	2,655.0
Gross Profit	179.5	224.0	165.5	265.3	481.6	278.0	178.5	285.4	468.1	357.8	441.1	726.0	713.0	834.3	1,223.5	1,993.0	5,059.5	10,506.3
Selling, general and administrative (includes COGS in actuals)	1,883.9	1,813.4	1,508.1	13.4	2,047.6	2,023.6	1,943.8	2,760.4	2,353.4	2,486.1	2,521.3	2,952.9	5,246.0	5,218.8	8,775.5	10,313.8	11,345.1	12,153.8
Research and development	1,143.8	857.0	722.4	1,872.7	863.6	844.5	658.9	405.9	722.0	745.0	750.0	700.0	6,242.9	4,595.8	2,772.9	2,917.0	3,135.7	3,292.5
Depreciation and amortization													-	-	-	-	-	
Total Operating Expenses	**3,027.68**	**2,670.41**	**2,230.42**	**1,886.1**	**2,911.2**	**2,868.2**	**2,602.7**	**3,166.3**	**3,075.4**	**3,231.1**	**3,271.3**	**3,652.9**	**11,488.8**	**9,814.6**	**11,548.4**	**13,230.7**	**14,480.9**	**15,446**
Operating Income/(loss)	**(2,848.2)**	**(2,446.5)**	**(2,064.9)**	**(1,620.8)**	**(2,429.6)**	**(2,590.2)**	**(2,424.2)**	**(2,880.9)**	**(2,607.3)**	**(2,706.1)**	**(2,591.3)**	**(2,602.9)**	**(10,775.8)**	**(8,980.3)**	**(10,324.9)**	**(10,507.6)**	**(7,756.9)**	**(2,285.0)**
Other Income:																		
Interest and exchange income (expense)	2.5	(6.3)	(2.4)	(2.5)	(2.2)	8.6	0.6	6.1	0.2	0.1	0.1	0.1	8.1	(8.7)	13.1	0.6	0.8	1.1
Interest expense	(85.5)	(143.1)	(138.6)	(174.5)	(158.3)	(174.6)	(131.3)	(282.1)	(166.2)	(166.2)	(166.2)	(166.2)	(729.6)	(541.8)	(746.2)	(664.7)	(664.7)	(664.7)
Debt Conversion cost	-	-	-	-	-	-	-	(724.6)	-	-	-	-			(724.6)	-	-	-
Gain on debt settlement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	-	-	-
Loss on asset disposal	-	-	(25.1)	24.7	(15.8)	-	-	0.7	(24.8)	-	-	-	-	(0.4)	(15.1)	-24.8	-	-
Derivative income	-	-	-	-	-	-	-	380.0	65.9	-	-	-	-	-	380.0	65.9	-	-
Other	-	-	-	-	-	-	-	-	(124.8)	-	-	-	-	-	-	(124.8)	-124.8	-
Income (loss) before provision for income taxes	**(2,931.3)**	**(2,595.9)**	**(2,231.0)**	**(1,773.2)**	**(2,605.8)**	**(2,756.1)**	**(2,554.9)**	**(2,776.2)**	**(2,857.0)**	**(2,872.1)**	**(2,757.3)**	**(2,768.9)**	**(11,497.3)**	**(9,531.3)**	**(11,417.7)**	**(11,255.4)**	**(8,545.6)**	**(2,948.5)**
Tax: (%) non-GAAP	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0*
Income tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net income (loss)	**(2,931.3)**	**(2,595.9)**	**(2,231.0)**	**(1,773.2)**	**(2,605.8)**	**(2,756.1)**	**(2,554.9)**	**(2,776.2)**	**(2,857.0)**	**(2,872.1)**	**(2,757.3)**	**(2,768.9)**	**(11,497.3)**	**(9,531.3)**	**(11,417.7)**	**(11,255.4)**	**(8,545.6)**	**(2,948.5)**
Foreign currency translation adjustment	(34.3)	12.3	2.1	(1.3)	(11.5)	12.2	5.8	23.1	0.8	-	-	-	**18.6**	(21.2)	29.6	0.8	-	-
Total Comprehensive Loss	**(2,965.6)**	**(2,583.6)**	**(2,228.8)**	**(1,774.4)**	**(2,617.3)**	**(2,743.9)**	**(2,549.1)**	**(2,753.1)**	**(2,856.2)**	**(2,872.1)**	**(2,757.3)**	**(2,768.9)**	**(11,478.7)**	**(9,552.5)**	**(11,388.1)**	**(11,254.6)**	**(8,545.6)**	**(2,948.5)**
Diluted EPS (GAAP)	**(0.11)**	**(0.09)**	**(0.08)**	**(0.06)**	**(0.08)**	**(0.07)**	**(0.06)**	**(0.05)**	**(0.04)**	**(0.04)**	**(0.04)**	**(0.04)**	**(0.55)**	**(0.33)**	**(0.25)**	**(0.17)**	**(0.13)**	**(0.04)**
Weighted Diluted Shares outstanding	27,356.3	28,084.1	29,245.4	31,126.5	34,517.6	40,866.2	43,952.0	54,152.8	65,455.8	65,455.8	65,455.8	65,455.8	20,925.5	28,953.1	45,044.6	65,455.8	67,678.0	69,344.7
Weighted Diluted Shares YOY change (%)					*26.2%*	*45.5%*	*50.3%*	*74.0%*	*89.6%*	*60.2%*	*48.9%*	*20.9%*		*38.4%*	*55.6%*	*45.3%*	*3.4%*	*2.5%*

Source: Bloomberg LP; Company reports; Laidlaw & Company estimates

Figure 17: Balance Sheet

PROTEA BIOSCIENCES GROUP, INC. *Balance Sheet ($ 000s, except per share data)*	FY 2013 Q1_13 Mar	 Q2_13 Jun	 Q3_13 Sept	 Q4_13 Dec	FY 2014E Q1_14 Mar	 Q2_14E Jun	 Q3_14E Sept	 Q4_14E Dec		FY_11 Dec	FY_12 Dec	FY_13 Dec	FY_14E Dec	FY_15E Dec	FY_16E Dec
Assets:															
Cash and cash equivalents	89.1	308.6	41.0	1,086.3	313.3	7,159.6	2,919.1	4,567.9		505.3	27.6	1,086.3	4,567.9	6,704.9	9,291.2
Restricted Cash		-	-	-	-	-	-	-		50.0	-	-	-	-	-
Trade accounts receivable	403.9	228.4	66.6	216.9	115.3	29.4	(37.0)	(107.1)		76.7	127.7	216.9	(107.1)	(314.4)	(615.4)
Other receivables	312.6	35.2	27.7	435.3	436.9	436.9	436.9	436.9		315.6	308.9	435.3	436.9	436.9	436.9
Inventory	600.7	607.6	591.4	465.3	553.4	620.6	753.9	1,014.0		223.3	905.2	465.3	1,014.0	2,003.9	3,172.4
Prepaid Expenses	50.0	57.3	103.9	304.7	134.6	134.6	134.6	134.6		141.4	29.6	304.7	134.6	134.6	134.6
Total Current Assets	**1,456.3**	**1,237.2**	**830.6**	**2,508.5**	**1,553.5**	**8,381.1**	**4,207.5**	**6,046.4**	-	**1,312.2**	**1,399.0**	**2,508.5**	**6,046.4**	**8,966.0**	**12,419.8**
Property and equipment, net	2,579.1	2,558.3	2,389.1	2,886.2	3,324.8	3,574.8	3,824.8	4,274.8		3,319.2	2,790.5	2,886.2	4,274.8	5,274.8	6,374.8
Other noncurrent assets	22.1	22.3	22.9	23.2	23.2	23.2	23.2	23.2		17.6	22.6	23.2	23.2	23.2	23.2
Total Assets	**4,057.5**	**3,817.8**	**3,242.7**	**5,417.9**	**4,901.5**	**11,979.1**	**8,055.4**	**10,344.4**		**4,649.1**	**4,212.0**	**5,417.9**	**10,344.4**	**14,263.9**	**18,817.7**
Liabilities & Shareholders' Equity:															
Current maturities on short and long-term debt	1,495.4	1,294.2	3,038.0	1,054.1	1,221.2	1,221.2	1,221.2	1,221.2		398.4	1,374.5	1,054.1	1,221.2	1,221.2	1,221.2
Accounts payable	1,241.0	1,068.9	1,662.3	759.0	1,671.5	1,756.2	1,778.0	1,985.4		2,504.1	2,270.7	759.0	1,985.4	2,173.0	2,317.8
Bank line of credit	2,725.0	2,725.0	2,725.0	2,725.0	3,000.0	2,600.0	1,000.0	-		3,000.0	2,725.0	2,725.0	-	-	-
Loans payable to stockholders	3,123.2	3,673.2	620.0	465.9	1,070.9	1,070.9	1,070.9	1,070.9		-	2,898.2	465.9	1,070.9	1,070.9	1,070.9
Obligation related to letter of credit	600.0	443.9	377.7	152.0	69.8	69.8	69.8	-		750.0	-	152.0	-	-	-
Other payables and accrued expenses	1,205.0	1,127.4	410.7	1,069.2	862.5	862.5	862.5	862.5		310.9	764.5	1,069.2	862.5	862.5	862.5
Total Current Liabilities	**10,389.7**	**10,332.8**	**8,833.7**	**6,225.1**	**7,895.9**	**7,580.6**	**6,002.4**	**5,140.0**		**6,963.4**	**10,032.8**	**6,225.1**	**5,140.0**	**5,327.6**	**5,472.4**
Option fee	-	-	-	-	300.0	300.0	300.0	300.0							
Long-term debt - net of current portion	1,942.8	1,815.0	1,698.4	1,580.3	1,754.3	1,754.3	1,754.3	1,754.3		2,189.5	2,083.0	1,580.3	1,754.3	1,754.3	1,754.3
Derivative Liabilities	-	-	-	623.6	557.7	557.7	557.7	557.7		-	-	623.6	557.7	557.7	557.7
Total Liabilities	**12,332.5**	**12,147.8**	**10,532.1**	**8,429.0**	**10,507.9**	**10,192.5**	**8,614.4**	**7,751.9**	-	**9,152.9**	**12,115.9**	**8,429.0**	**7,451.9**	**7,639.5**	**7,784.4**
Stockholders' Equity	**(8,275.0)**	**(8,330.0)**	**(7,289.4)**	**(3,011.0)**	**(5,606.4)**	**4,398.5**	**2,053.0**	**5,204.4**		**992.0**	**(7,903.8)**	**(3,011.0)**	**2,892.4**	**6,624.4**	**11,033.3**
Total Liabilities & Equity	**4,057.5**	**3,817.8**	**3,242.7**	**5,417.9**	**4,901.5**	**11,979.1**	**8,055.4**	**10,344.4**		**4,649.073**	**4,212.0**	**5,417.9**	**10,344.4**	**14,263.9**	**18,817.7**

Source: Bloomberg LP; Company reports; Laidlaw & Company estimate

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Figure 18: Cash flow Statement

PROTEA BIOSCIENCES GROUP, INC. *Non-GAAP Cash Flow Cont. Ops.($ 000s, except per share data)*	**FY_11** Dec	**FY_12** Dec	**FY_13** Dec	**FY_14E** Dec	**FY_15E** Dec	**FY_16E** Dec
Cash flows from operating activities:						
Net income (loss)	(11,497.3)	(9,531.3)	(11,417.7)	(11,255.4)	(8,545.6)	(2,948.5)
Adjustments to reconcile net income to net cash provided by operating activities:				-		
Depreciation and amortization	1,279.6	1,009.1	844.9	929.5	976.0	1,024.8
Non-cash compensation	352.0	345.7	873.0	989.3	1,009.1	1,039.4
Issuance of common stock and warrants for services	-	-	345.7	30.5	30.5	30.5
Issuance of common stock for accrued interest	258.2	53.3	372.2	-	-	-
Accretion of convertible debenture discount	132.7	0.4	137.6	262.8	262.8	262.8
Debt conversion costs associated with inducement	-	-	724.6	-	-	-
Loss on disposal of fixed assets	-	30.0	15.1	24.8	-	-
Bad debt expense	-	-	4.0	2.0	-	-
(Income) Expense from change in value of derivative	-	-	(380.0)	(65.9)	-	-
Changes in assets and liabilities:						
Trade accounts receivable	(26.0)	(81.1)	(93.1)	321.9	207.3	301.0
Prepaid expenses	(75.5)	111.9	(275.1)	170.1	-	-
Other receivables	727.3	1.7	(127.0)	(1.6)	-	-
Inventory	43.7	(681.9)	439.9	(548.7)	(989.9)	(1,168.5)
Trade accounts payable	780.8	(233.4)	(1,989.5)	971.3	187.6	144.9
Obligation related to the Letter of Credit	-	-	-	(69.8)	-	-
Option fee				300.0	-	-
Other payables and accrued expenses	57.3	453.5	304.7	(206.7)	-	-
Net cash provided by (used in) operating activities	(7,967.2)	(8,522.0)	(10,220.8)	(8,145.9)	(6,862.2)	(1,313.7)
Cash flow from investing activities:						
Movement in restricted cash	(0.1)	50.0	-	-	-	-
Purchase of and deposits on equipment	(1,241.9)	(408.2)	(478.9)	(1,001.9)	(1,000.0)	(1,100.0)
Proceeds from sale of equipment	-	-	1.0	-	-	-
Cash provided by investing activities	**(1,242.0)**	**(358.2)**	**(477.9)**	**(1,001.9)**	**(1,000.0)**	**(1,100.0)**
Cash flows from financing activities:						
Net advances on bank line of credit	-	(275.0)	-	275.0	-	-
Proceeds from sale of common stock	2,282.1	5,738.5	9,352.8	14,987.5	10,000.0	5,000.0
Proeceeds from short and long-term debt	7,405.0	1,090.0	1,994.5	-	-	-
Proceeds from shareholder debt	-	2,148.2	1,000.0	605.0	-	-
Repayment of long-term debt	(402.0)	(278.0)	(858.2)	(21.2)	-	-
Proceeds from Obligation related to the Letter of Credit	-	-	600.0	(69.8)	-	-
Repayment of Obligation related to the Letter of Credit	-	-	(361.3)	(3,147.9)	-	-
Cash (used in) provided by financing activities	**9,285.1**	**8,423.7**	**11,727.9**	**12,628.6**	**10,000.0**	**5,000.0**
Effect of exchange rates on cash	18.6	(21.2)	29.6	-	-	-
Net (decrease) increase in cash and cash equivalents	94.6	(477.7)	1,058.7	3,480.8	2,137.8	2,586.3
Cash and cash equivalents at beginning of the period	410.7	505.3	27.6	1,086.3	4,567.1	6,704.9
Cash and cash equivanlents at end of period -	**505.3**	**27.6**	**1,086.3**	**4,567.1**	**6,704.9**	**9,291.2**

Source: Bloomberg LP; Company reports; Laidlaw & Company estimates

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Additional information available upon request.

‡ Laidlaw & Company has received compensation from the subject company for investment banking services in the past 12 months and expects to receive or intends to seek compensation for investment banking services in next 3 months?

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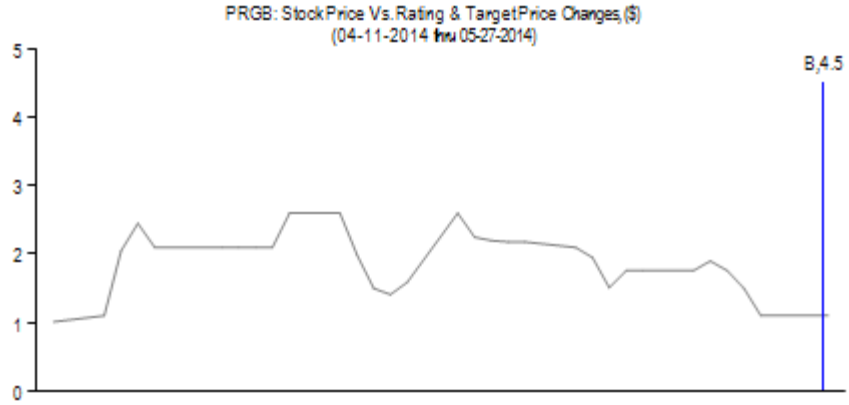
Rating and Price Target Change History



3 Year Rating Change History

Date	Rating	Closing Price ($)
05/27/2014	Buy (B)	1.10*

3 Year Price Change History

Date	Target Price ($)	Closing Price, ($)
05/27/2014	4.50	1.10*

** Previous Close5/23/2014*

Source: Laidlaw & Company **Created by: Blue-Compass.net**

Laidlaw & Company Rating System*		% of Companies Under Coverage With This Rating	% of Companies for which Laidlaw & Company has performed services for in the last 12 months	
			Investment Banking	Brokerage
Strong Buy (SB)	Expected to significantly outperform the sector over 12 months.	0.00%	0.00%	0.00%
Buy (B)	Expected to outperform the sector average over 12 months.	93.33%	40.00%	13.33%
Hold (H)	Expected returns to be in line with the sector average over 12 months.	6.67%	0.00%	0.00%
Sell (S)	Returns expected to significantly underperform the sector average over 12 months.	0.00%	0.00%	0.00%

ADDITIONAL COMPANIES MENTIONED

Agilent Technologies (A, Not Rated)
Bruker Corporation (BRKR, Not Rated)
Cepheid Inc. (CPHD, Not Rated)
Danaher Corporation (DHR, Not Rated)
Dow Chemical Company (DOW, Not Rated)
Fluidigm Corp. (FLDM, Not Rated)
Foundation Medicine Inc. (FMI, Not Rated)
General Electric Co (GE, Not Rated)
JEOL LTD (6951-TO, Not Rated)

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NanoString Technologies (NSTG, Not Rated)
Quintiles Transnational Holdings Inc. (Q, Not Rated)
Shimadzu Corp. (7701-TO, Not Rated)
Thermo Fisher Scientific Inc. (TMO, Not Rated)
Waters Corporation (WAT, Not Rated)

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