

Growth Strategy for Analytical & Measuring Instruments Business

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I. Business Outline

—Sales Trend, CAGR, Market Segments,
Products List, Aftermarket Business—

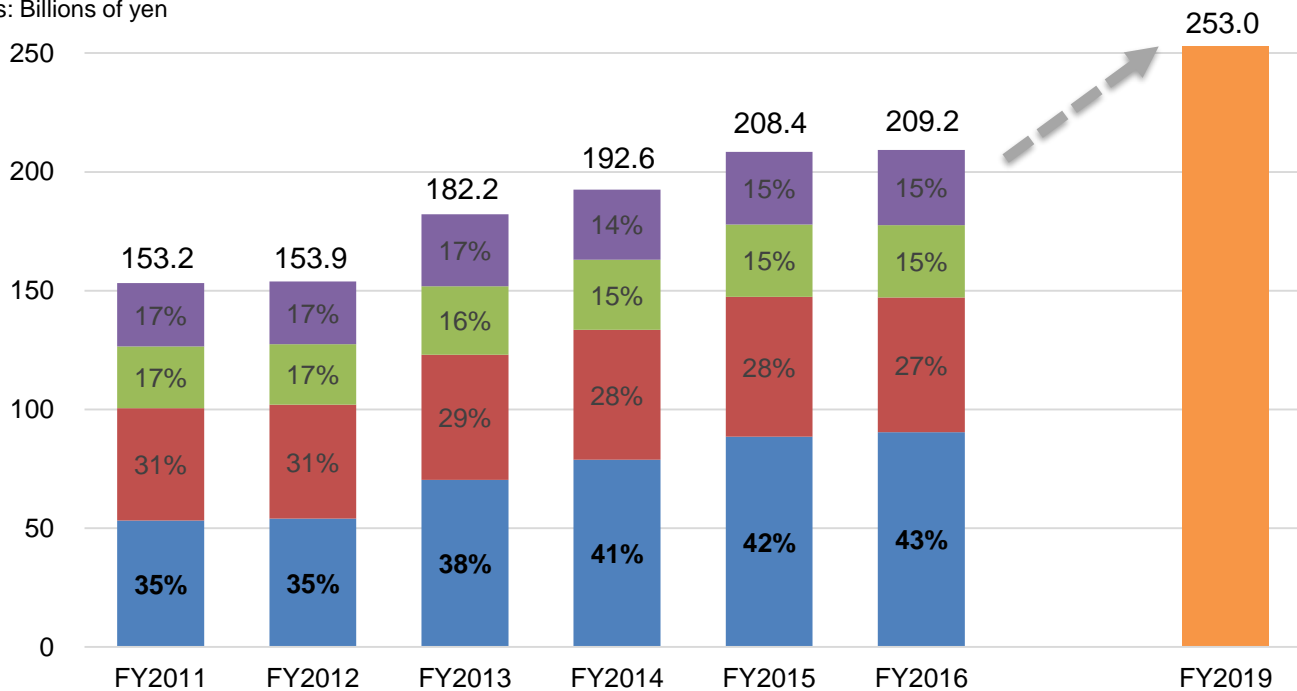


I. Outline of Analytical & Measuring Instruments

Business 1/5 —Sales Trend—

Results are driven by continued strong sales for LC and MS products

Units: Billions of yen



New Medium-Term Management Plan

■ LC, MS ■ General-Purpose Analysis ■ Surface/Testing Machine ■ Others

I. Outline of Analytical & Measuring Instruments

Business 2/5 —Business Growth—

High CAGR (FY2012 to FY2016) and improved profitability

- **Sustained income growth**

Net sales: 6 % CAGR

Operating income: 15 % CAGR

- **Improved profitability**

The operating margin increased significantly, from 8.2 % (FY2012) to 15.8 % (FY2016).

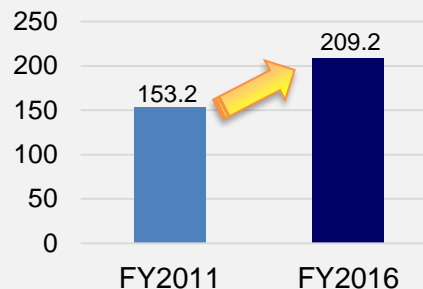
- **Growth drivers**

Products and services: 15 % CAGR for MS and 9 % CAGR for LC

Regions: **15 % CAGR in North America**, **13 % CAGR in India**, and **10 % CAGR in China**

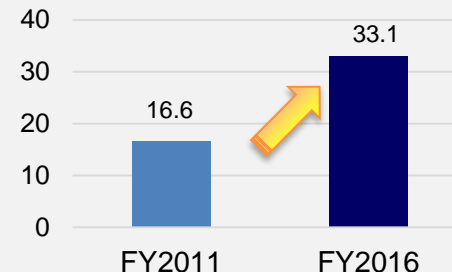
Net Sales

Units: Billions of yen



Operating Income

Units: Billions of yen



I. Outline of Analytical & Measuring Instruments

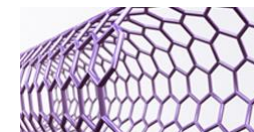
Business 3/5 —Market Segments—

Analytical & measuring instruments 3 to 5 % market growth rate forms stable markets

Pharmaceuticals and foods:
Biopharmaceuticals and food safety



Chemicals, energy, and the environment:
New materials, composite materials, materials analysis, alternative energy, and environmental monitoring



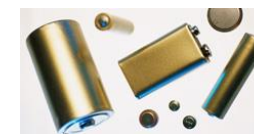
Academia and government:
Life sciences research and materials science research



Healthcare:
Ultra-early screening and treatment support

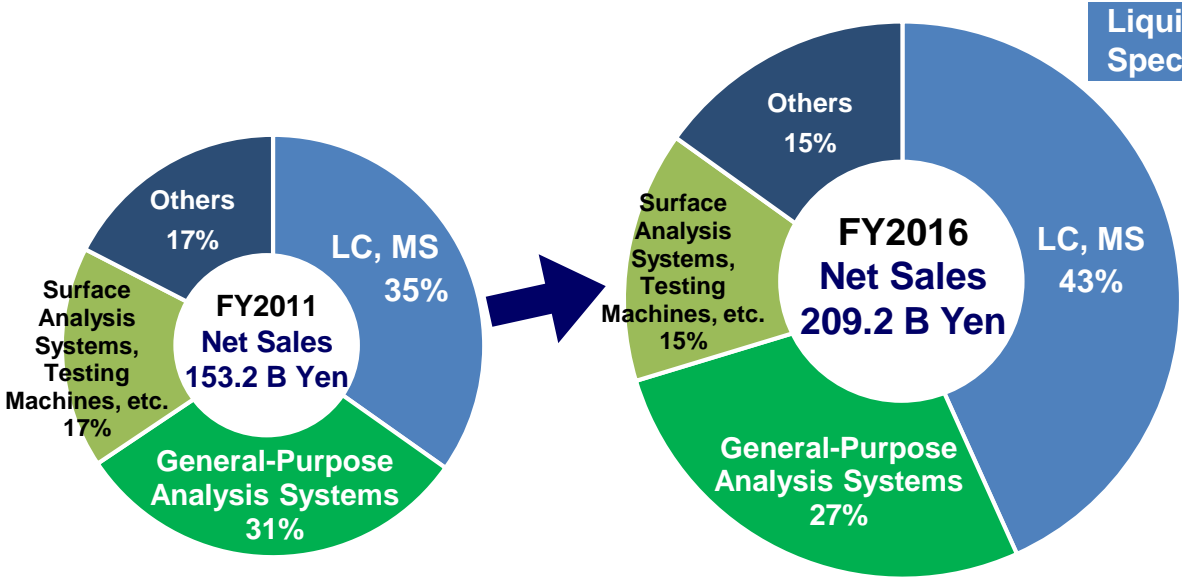


Other industries:
Automotive, electrical, and electronic goods



I. Outline of Analytical & Measuring Instruments

Business 4/5 —List of Primary Products—



Liquid Chromatographs (LC) and Mass Spectrometers (MS)



LC Nexera X2

—Growth Fields—
 Biopharmaceuticals
 Life science research
 Ultra-early screening
 Treatment support
 Food safety



LCMS-8060



GCMS-TQ8050

Surface Analysis Systems, Testing Machines, and Nondestructive Inspection Machines

—Growth Fields—
 New materials, composite materials, and materials analysis



EPMA-8050G Electron Probe Microanalyzer



Nondestructive Inspection Machine (X-CT)



Materials Testing Machine

General-Purpose Analysis Systems

—Growth Fields—
 Alternative energy and environmental monitoring



ICPMS-2030



AIM-9000 Infrared Microscope

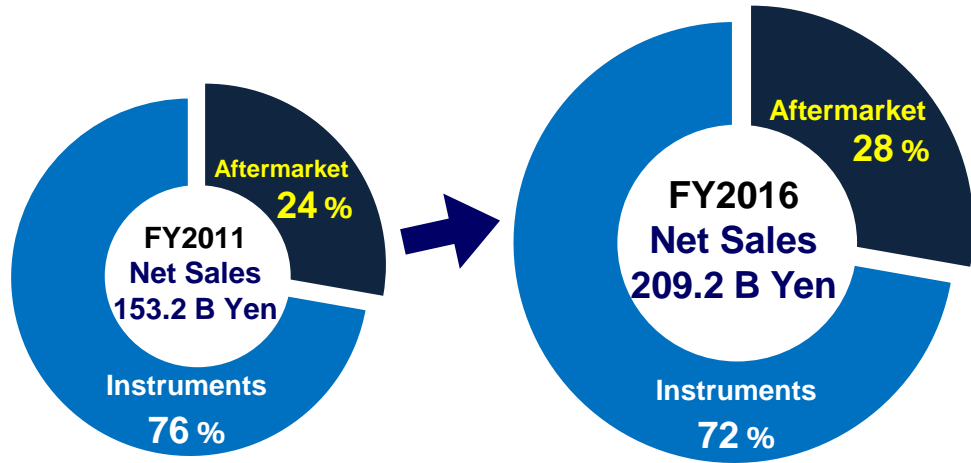


GC-2030 Nexis

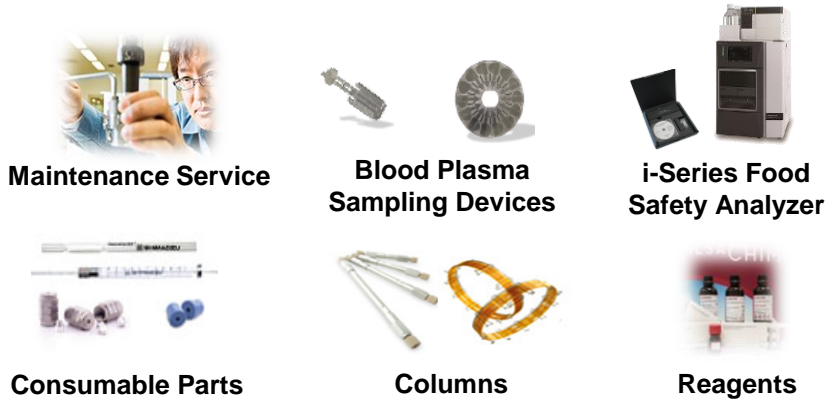
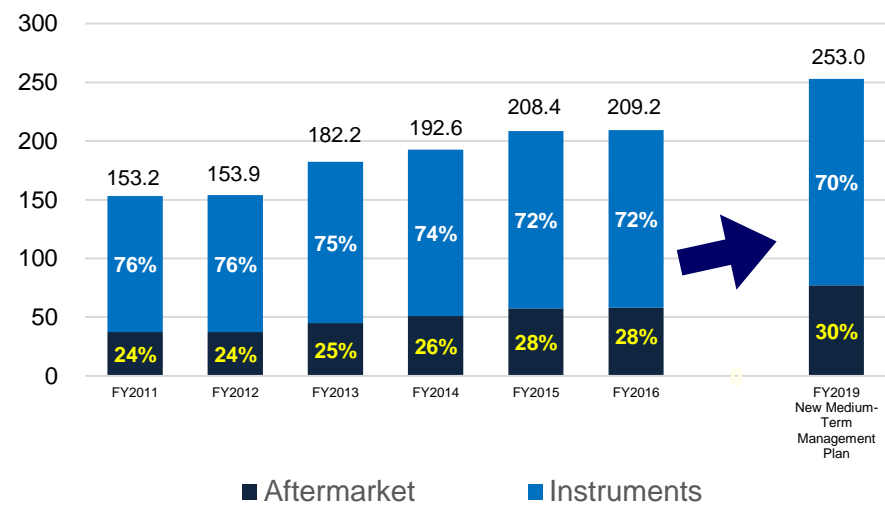


LC i-Series

I. Outline of Analytical & Measuring Instruments Business 5/5 —Aftermarket Business—



Units: Billions of yen



- Expand preventive maintenance
- Expand specialized analyzers and application-specific reagents

A photograph of two scientists in a laboratory. A man on the left is using a pipette to transfer liquid into a beaker. A woman on the right is holding a beaker with green liquid and pouring it into a flask. The background shows various lab equipment like beakers and flasks on a bench.

II. Growth Strategies

—Advanced Healthcare and Materials—

II. Growth Strategies

A. Advanced Healthcare 1/6—Overview



Prevention

Ultra-Early Screening

Mass Spectrometry
Health Screening and
Group Examination

Diagnosis and Treatment

Mass Spectrometry
Treatment Support and
Medication Management

Prognosis Management

NIRS
Improved QOL

Cancers

- Food safety and security
 - Food with enhanced functionality
 - Supplements
- "Contribute to the development of foods, beverages, and pharmaceuticals that improve health."

Lifestyle Diseases

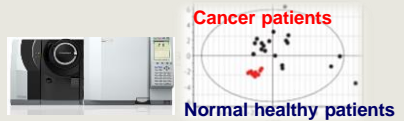


Dementia



Screening

- Ultra-early screening



Treatment Support

- Pathological diagnostic support
- Cancer treatment method research support



Treatment Support: Combine MS data with CVS images

- Primary aldosteronism (high blood pressure) treatment support
- Sampling adrenal cortex vein
- Identifying blood collection location
- Deployment for other lifestyle diseases

Screening

- Early examination of mild cognitive impairment (MCI)



Therapeutic Effect Measurement

- Determination of the therapeutic effect
- Effective rehabilitation



II. Growth Strategies

A. Advanced Healthcare 2/6

Cancers

Ultra-early screening

Colon Cancer Screening: Joint development with Kobe University School of Medicine

- **Background of Development**

Methods are needed for accurately determining the presence of colon cancer, which has one of the highest mortality rates of all cancers, at an early stage, when there is still a high probability of being fully cured.

- **Description of Development**

Shimadzu and the Kobe University Hospital are jointly developing a technique for accurately determining the presence of colon cancer by using GCMS to quantify compounds in the blood that are unique to colon cancer.

Currently they are developing a fully automatic system that encompasses pretreatment and sample extraction.

- **Next Steps**

Start using the system for procedures not covered by national health insurance and register the system as a medical system for early stage cancer diagnosis.

In the future, expand uses to other uncovered services (elective medical examinations), such as for checking for multiple cancers, mild cognitive impairment, mental illness, or diabetic nephropathy from a single blood sample.



II. Growth Strategies

A. Advanced Healthcare 3/6

Cancers

Faster tissue examination

Support for Rapid Cancer Diagnosis: Joint development with the University of Yamanashi Faculty of Medicine

- **Background of Development**

A powerful technique is needed that is able to support immediately diagnosing cancers during surgery and that results in higher patient QOL.

- **Description of Development**

Develop a mass spectrometer that is able to analyze, on-site, tissue samples acquired from patients undergoing surgery in the operating room to provide powerful support for cancer determinations by pathologists and provide an effective means of determining the tissue resection range and so on.

Currently considering expanding scope from liver cancer to other cancers.

- **Next Steps**

Start clinical trials for liver cancer and apply for approval for a pharmaceutical system.

Deploy as on-site analysis systems for forensics, food and environmental testing, and other fields.



University of Yamanashi
Faculty of Medicine



II. Growth Strategies

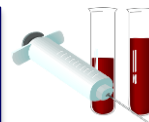
A. Advanced Healthcare 4/6

Lifestyle
Diseases

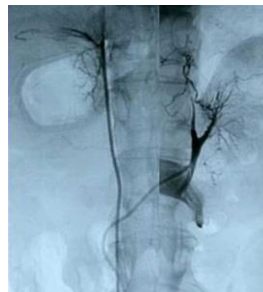
New medical solutions based on merging analytical (LCMS data) and medical (CVS Imaging) technologies

■ Research and development of system for supporting adrenal vein sampling during diagnosis and treatment of primary aldosteronism

- During examinations for primary aldosteronism, a cause of high blood pressure, blood collected from the adrenal vein is analyzed at high speed and high sensitivity using a liquid chromatograph mass spectrometer (LCMS) and then information from the examination is provided as feedback for medical treatment.
- Enables efficient diagnosis and treatment processes and reduces the burden on patients.
- Started joint research with Tohoku University Hospital.
- Considering use for other diseases as well



+



- Blood is collected by inserting a catheter into an adrenal vein.
- The blood is analyzed by high-speed and high-sensitivity LCMS for excessive secretion of aldosterone, a cause of high blood pressure, and then the examination information is quickly fed back for medical treatment.
- Achieving efficient diagnosis provides a seamless flow from examination to treatment and reduces the burden on patients.

Contrast Enhanced Image of Adrenal Blood Vessels
Image source: Tohoku University Hospital



II. Growth Strategies

A. Advanced Healthcare 5/6



Dementia

Examination of mild cognitive impairment (MCI)

MCI Screening: Joint investment with Taiyo Life Insurance Company in MCBI, a venture company originating from the University of Tsukuba
Participation in mild cognitive impairment screening business

- **Background of Investment**

With the rapid increase in dementia patients as the population ages (about 7 million in Japan by 2025), developing effective new drugs can be difficult, but it is more important to provide treatment at a mild stage.

- **Next Steps**

- Use MS to improve accuracy of MCI screening examinations.
- Offer screening examinations for cancer and lifestyle diseases.



II. Growth Strategies

A. Advanced Healthcare 6/6

Expanding the reagent business

- Announced acquisition of French reagent company **Alsachim** in June 2017.
- Acquired manufacturing function for stable isotopes, which are critical for quantitative analysis using mass spectrometers (MS).
- Shimadzu and Alsachim develop new reagent kits for healthcare fields.
- Pursue synergies between instruments and reagents.
- Application examples: Monitoring immunosuppressants, anticonvulsants, and other drugs in the blood



II. Growth Strategies

B. Materials Science 1/2

Offer evaluation systems essential for developing functionally engineered materials for automobiles, electronics, structural members, and other applications

Development of High-Performance Composite Materials

- Materials Design Support**
- Evaluation of composites to increase strength and reliability
 - Evaluation of polymer materials

Application Research Support

- Surface treatment technologies
- Evaluating joints between dissimilar materials
- Machining/fabrication technologies
- Analysis of production technologies

Failure Process

Visualization



+



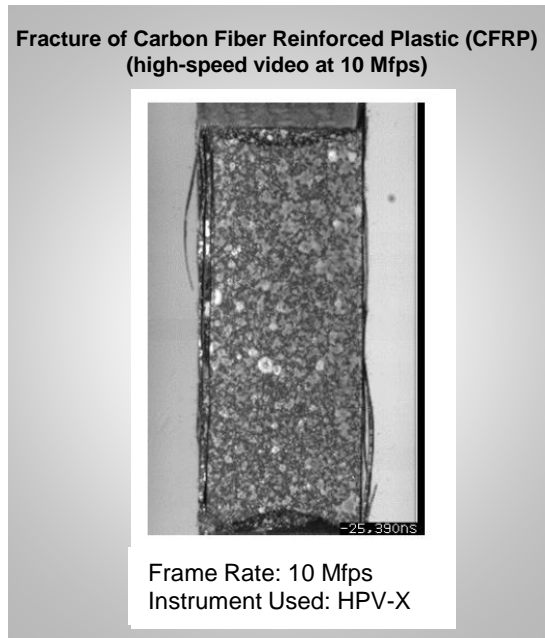
- Visualize fracture behavior using a combination of high-speed impact testing machine and high-speed video camera.
- Evaluate reliability of CFRP in aircraft, spacecraft, or automobiles.

Fatigue Life Evaluation

Increasing Speed



- 10^7 cycle fatigue tests can be performed in 10 minutes.
- Accelerated testing of material fatigue life
- Optimal truly unique products for evaluating material life and testing high-speed vibration reproducibility



II. Growth Strategies

B. Materials Science 2/2

Offer analysis systems and physical property analysis systems for developing next-generation high-capacity batteries with applications expected to expand for smartphones, EVs, etc.

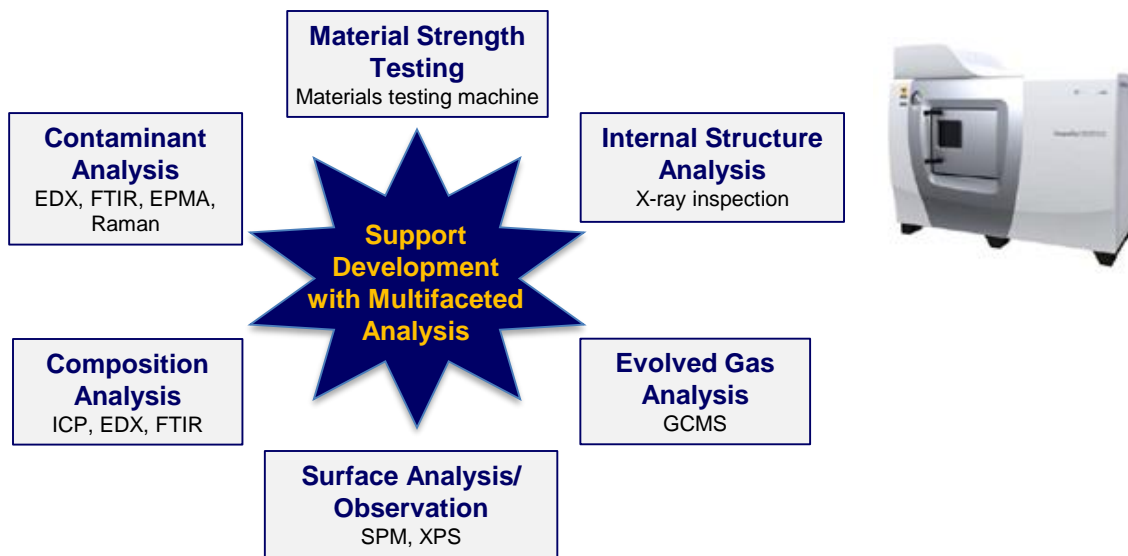
Next-Generation Battery Materials

Multifaceted Safety Evaluation

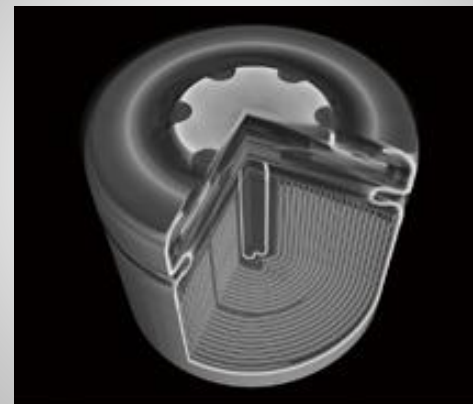
- Material strength testing + internal X-ray observation + evolved gas analysis + surface analysis and surface observation

Development Support for High-Capacity Battery Materials

- Evaluation of materials and reliability for developing such materials



Observation Example:
Model 18650 lithium-ion rechargeable battery
Microfocus X-Ray Inspection System





III. Product Strategies

—LC, MS, New Products, Cellular Analysis
Business, and Regulation Compliance—

III. Product Strategies 1/8

A. Liquid Chromatographs

Overview

- **Market Conditions and Market Share**

Continued steady growth in demand globally, with about 3 % projected market growth.

Demand mainly expected from private sector pharmaceuticals/biotech and academia/government.

Market size of about 500 billion yen.

Demand is projected to expand in examination and diagnosis healthcare fields.

- **Growth Strategies**

- Expand product lines not only for general-purpose LC and high-speed LC, but also for ion chromatographs, micro LC, and inert LC. Also expand consumables business by developing specialized models.
- Use AI and IoT technologies to improve network systems and expand service businesses, such as preventive maintenance.
- Use LC technologies to develop systems for handling cells, analyzing cell metabolites, and so on, and use iPS cells for safety and toxicity testing during drug discovery.

III. Product Strategies 2/8

A. Liquid Chromatographs

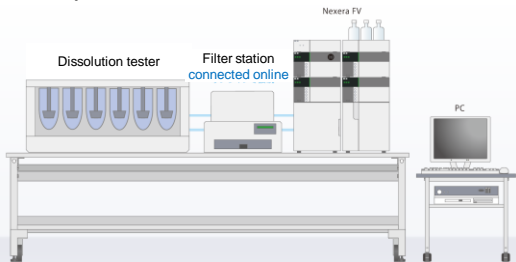
New Products

Achieves increased speeds and automation for R&D and QC of generic drugs and other drug products.



Ultra High Performance
Liquid Chromatograph for
Online Dissolution Testing
Nexera FV

- Connect an ultra fast LC and a dissolution tester online.
- Dramatically shorten operator time requirements.



Ideal for testing the stability of pharmaceuticals, such as during analytical method development/manufacturing or during process control

Liquid Chromatograph

i-Series Plus



- Improve operability by automating pretreatment operations, such as adding reagents.
- Improve stability with dual-temperature control functionality.
- Sold more than 10,000 i-Series units in total since its release in 2014.

All laboratory analytical systems compliant with pharmaceutical data integrity requirements

Data System Compatible with Analytical Laboratory Networks

LabSolutions CS



III. Product Strategies 3/8

B. Mass Spectrometers

Overview

- **Market Conditions and Market Share**

With technical innovation and expanding application fields expected to continue, a high market growth of about 7 % is projected.

Wide variety of fields with significant demand, such as pharmaceuticals, biotech, food testing, healthcare, and chemicals in the private sector, and academia and government in the public sector.

Market size of about 400 billion yen

- **Growth Strategies**

Strengthen offering of specialized software for pharmaceutical applications.

- **LabSolutions Connect**

Seamless operability for processes from developing methods for new compounds to quantitative analysis at pharmaceutical companies (such as pharmacokinetics), contract analysis companies, and other users.

- **LabSolutions Insight**

Quantitative analysis software for analyzing multiple components/analytes in regulated compounds for pharmaceutical manufacturing and so on.

Strengthen the product line for on-site analysis and deploy the products in fields such as pharmaceutical manufacturing, screening examination, and food testing. (See the next page.)

Develop expert systems based on using AI and IoT technologies for sophisticated data processing and analysis.

Accelerate deployment of molecular diagnostic, cellular, and other technologies in healthcare fields.

III. Product Strategies 4/8

B. Mass Spectrometers

New products: Expand/improve direct MS product line

Deploy for confirming molecular weight or measuring profiles of biopharmaceuticals, chemicals, materials, or other items.

Benchtop MALDI-TOF Mass Spectrometer

MALDI-8020™



- Achieves highest level of performance in benchtop model.
- Space-saving and light weight
- Low running cost

Analyze in about 2 minutes with only simple pretreatment and deploy for on-site analysis, such as for forensics and quality control

Probe Electrospray Ionization Mass Spectrometer

DPiMS-2020



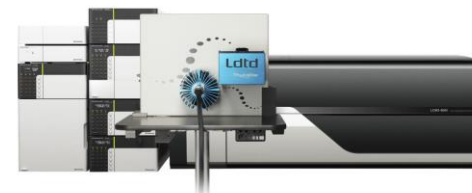
- Enables rapid analysis with only simple pretreatment.
- MS unit features high contamination-resistance and low maintenance frequency.

Screening and confirmation testing, such as for pharmaceutical, clinical, and food safety testing and ultra fast analysis

Optional Product for LCMS-8050/8060 Ultra Fast Liquid Chromatograph Mass Spectrometer

LDTD® Ion Source

- Direct ion source for achieving ultra fast analysis
- Switch between LCMS and LDTD-MS modes, with LDTD ion source left connected.
- Includes software for entire analysis process workflow.



III. Product Strategies 5/8

C. New Products

Gas chromatographs

High-end gas chromatograph that offers world's highest level of sensitivity and reproducibility, high expandability, improved usability, and lower running costs.

Nexis GC-2030

Application Systems (Examples)

- Trace moisture content measurement system (developed at the US Innovation Center)
- Liquefied natural gas analysis system (developed at the US Innovation Center)
- Refinery gas analysis system
- Hydrocarbon analysis system
- Public utility gas analysis system
- Gasoline analysis system
- Inorganic gas analysis system



Compact gas chromatograph that combines multi-dimensional analysis with high-separation high-speed analysis capability in a compact instrument

Compact Analyzer Gas Chromatograph

Nexgen GC

- Smaller, faster, and higher separation, due to proprietary Shimadzu plate column technology
- Opens new market opportunities, such as for process monitoring and mobile on-site analysis.

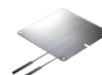


Plate Column

100 mm × 100 mm square
1 mm thick

III. Product Strategies 6/8

C. New Products

Compact high resolution FTIR scanning probe microscope

Offers both high sensitivity and high throughput in a compact size
 Also, offers simple operability for deployment in a wide range of fields.

FTIR Spectrophotometer
IRSpirit



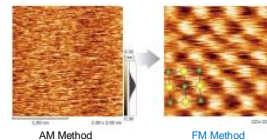
- Offers the same high reliability, throughput, and sensitivity as higher-end models.
- Dedicated program makes analysis easy
- Design enables access from two sides, for more layout flexibility.

High resolution provides sharp images that expands applicability in cutting-edge nanotechnology research fields.

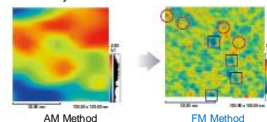
High Resolution Scanning Probe Microscope
SPM-8100FM
HR-SPM



Atomic Resolution Observation in Solution



Pt Catalyst Particles Observation in Air¹⁾



KPFM : Kelvin Probe Force Microscope

- High resolution enables sharper images.
- Surfaces can be observed in air or solution, in addition to vacuum atmospheres.

III. Product Strategies 7/8

D. Cellular Analyses (Regenerative Medicine and Drug Discovery Fields)

Higher reproducibility, quality, and productivity of cell cultivation

Suspension-Culturing iPS Cells

Eliminates the need to replace culture media each day.

Three-Dimensional Rotating Suspension Cell Culturing System
CELLFLOAT system



Monitoring Cell Cultivation Status

High-speed simultaneous analysis of 95 components



LC/MS/MS method package for profiling cell cultures

Cell Measurement and Process Control

History management and error/contaminant detection

Cell Culture Analysis System
CS-1 Culture Scanner



Single-Button Cell Picking

Improving productivity of culturing process



Cell Culturing Support System
Cell Picker

III. Product Strategies 8/8

E. Participation in Creating Regulations

Participate in creating various regulations for environmental testing, energy, and other fields and develop products and applications in cooperation with regulatory authorities

Global Regulations	Content	Related Products
Revised RoHS Directive	Participate in creating the international standard IEC 62321—Part 8 (testing method for phthalate esters) and develop products compliant with the standard.	Py-Screener (GC/MS system with pyrolyzer)
Chemical substance regulations by the United States Environmental Protection Agency (EPA)	Total nitrogen analysis method adopted as ASTM-D8083	TOC total organic carbon analyzer
Measurement of trace moisture content in LPG	Standard testing method submitted to ASTM as official method for United States	Trace moisture content measurement system using GC and BID units
Standardization (adopted by ISO) of high-speed plastic tensile testing method	Participate in creating high-speed tensile testing method for evaluating strain-rate dependence of plastics.	Hydroshot HITS-T series hydraulically controlled high-speed tensile testing machines

Japanese Regulations	Content	Related Products
Revision to the order for enforcement of the High Pressure Gas Safety Act	Analytical systems with a capacity of 100 mL or less were excluded from the High Pressure Gas Safety Act, which eliminated the need for permit applications or data submission.	Nexera UC supercritical fluid extraction chromatograph system
Revision to regulation (notification) for controlled medical devices requiring special maintenance, specified by the Minister of Health, Labour and Welfare	Classification for mass spectrometers added to clinical chemical inspection systems	High-performance liquid chromatograph mass spectrometer (LCMS)



IV. R&D

—R&D Capabilities and Innovation Centers—



IV. R&D 1/2

A. R&D Capabilities

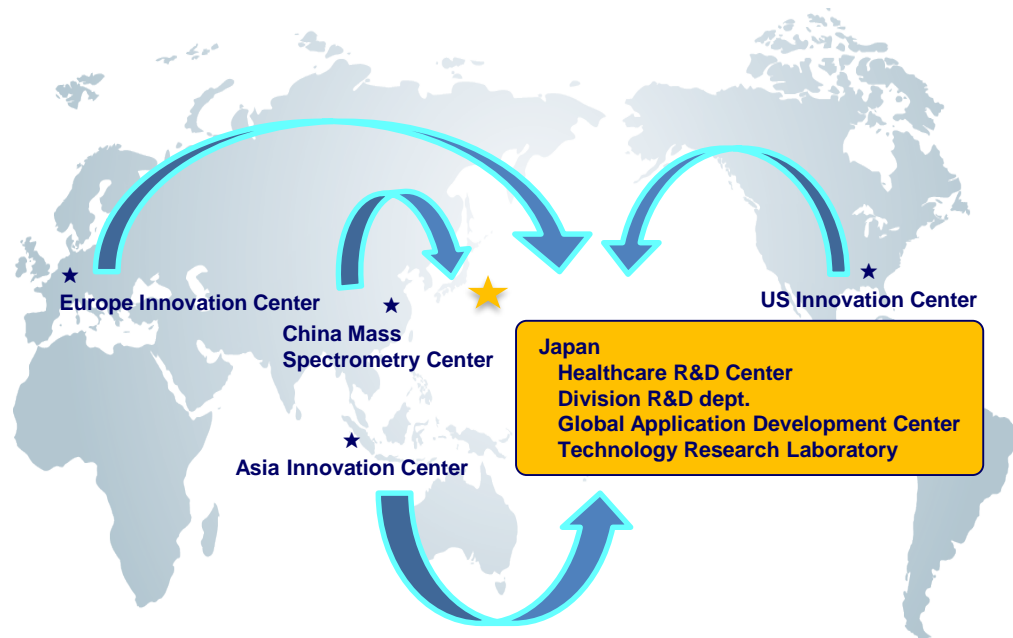
Strengthen, expand, and improve R&D functions globally and accelerate development speed

● Healthcare R&D Center

- Core organization for implementing global joint research with healthcare research institutions
- Also collaborates with innovation centers outside Japan.
- Promotes advanced healthcare solutions by merging analytical/measuring and medical technologies, such as combining mass spectrometry with diagnostic imaging technologies.
- As a location for open innovation, the center actively promotes joint research with researchers outside Shimadzu.
- Scheduled to start operations January 2019.



Location Planned for Construction of Healthcare R&D Center (photographed July 2017, within head office grounds)



IV. R&D 2/2

B. Deployment of Innovation Centers

	Development Theme	Field	Overview	Joint Research Organization
US Innovation Center	MS system for measuring pain medication in urine	Healthcare	Development of reagent kit Development of automatic pretreatment system for which the FDA approval is obtained	Johns Hopkins University
	System for evaluating environmental pollution associated with shale gas extraction	Environmental Energy	Development of method and applications for analyzing PAHs in soil by online SFE-SFC/MS	The University of Texas at Arlington
	Trace moisture content measurement system that is compliant with various analytical standards, such as for petroleum, chemical, and pharmaceutical products	Chemicals	Development of moisture content analyzer that combines HS-20 headspace sampler with a BID detector	The University of Texas at Arlington
Europe Innovation Center	Pharmaceutical applications (toxicity safety field)	Healthcare	Deployment of iMScope imaging applications (imaging biological samples)	University of Münster (Germany)
	Analysis of components with functional benefits in foods	Foods	Analysis (by SFE/SFC-EI system) of functionally engineered foods (EPA/DHA), natural/artificial flavorings, and so on	University of Messina (Italy)
	Fatigue testing system	Composite materials	Use ultrasound to achieve ultra fast fatigue testing of composite materials.	TU Dortmund University (Germany)
China Mass Spectrometry Center	Kinetic observation of drugs, metabolites, lipids, etc. using iMScope	Imaging	Development of sample pretreatment and analysis methods	Tsinghua University Graduate School of Pharmaceutical Sciences
	GC×GCMSMS system for simultaneous analysis of SCCPs (short-chain chlorinated paraffins)	Environmental	Establish and package pretreatment and analytical conditions for GC×TQ-GCMS systems.	National Research Center for Environmental Analysis and Measurement
Asia Innovation Center	New solutions (LCMS) for pharmaceuticals companies for quantitative analysis of other analytes and components	Healthcare	Software for creating reports, such as for pharmaceutical companies in India Software for monitoring usage, and so on, of laboratory equipment and software	Pharmaceutical companies in India
	Comprehensive research of environmental analysis	Environmental	Development of sensor system for measuring nutritional value of environmental waters, due to fertilizers or other factors	National University of Singapore

V. Conclusion

- Satisfy broad demand for analytical systems, for applications ranging from cutting-edge to general-purpose, by offering an extensive line of products and services.
- Create new demand not only in the healthcare field, but also in the growth fields of new materials, automobiles, and environmental/energy testing.
- Release an unbroken stream of high value-added products and services based on a core of liquid chromatographs and mass spectrometers in a broad range of fields ranging from pretreatment to aftermarket.
- Create new demand by also actively contributing to creating global regulations, such as environmental and food safety.
- Embrace the challenge of creating number-one and truly unique products by strengthening R&D functions globally, such as innovation centers and Healthcare R&D Center, and accelerating joint research projects in advanced fields.





This document contains forward-looking statements. Forecasts of future business performance that appear in this document are predictions made by the company's management team that are based on information available when these materials were prepared and are subject to risks and uncertainties. Consequently, actual results may differ materially from the forecasts indicated above. Factors that may influence actual business performance include, but are not limited to, economic conditions within and outside Japan, changes in technologies in markets, and fluctuations in exchange rates.