SHIMADZU
Excellence in Science

Shimadzu Corporation Research and Development Strategy

—Open Healthcare R&D Center, Successively Expand/Improve Research Functions, and Significantly Expand Overall Technological Capabilities—

Teruhisa Ueda
President & CEO
Shimadzu Corporation

June 7, 2019

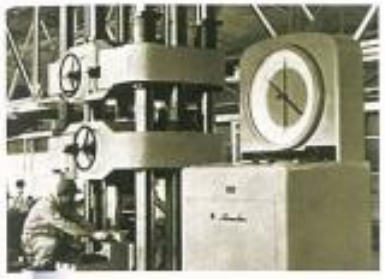
Shimadzu Corporation Research and Development Strategy

Content

I. Shimadzu's History

A. From Foundation to Today

Timeline of Shimadzu Development History



Japan's First General-Purpose Gas Chromatograph

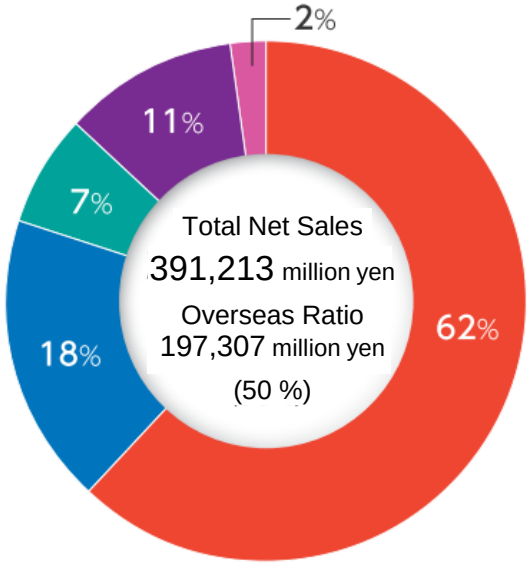
Early High-Performance Liquid Chromatograph

	Physics and Chemistry Equipment	Medical Systems	Analytical and Measuring Instruments/ Aircraft Equipment/Industrial Machinery		
Meiji	Distiller and exhauster awarded prize at National Industrial Exhibition. Genzo Jr. builds Wimshurst electrostatic generator. Air-gas generators/GS burners	Successfully produces an X-ray photograph. Educational X-ray apparatuses Completes Japan's first medical X-ray system.		The G.S. storage battery registered as a commercial trademark.	Establishes Specimen Department. Human anatomical models
Taisho	Equipment for student experiments	DIANA general-purpose X-ray system Conducts X-ray training class.	Optical measuring instruments Gear machinery Materials testing machines	Transferred to Japan Storage Battery Co., Ltd. Currently: GS Yuasa Corporation	Starts manufacturing mannequins.
Showa	G.S. apparatuses for experiments Transferred to Shimadzu RIKA Corporation.	Establishes the Shimadzu X-Ray Technology Training Center. Currently: Kyoto College of Medical Science X-ray tubes and rectifier tubes Develops world's first remote-controlled fluoroscopy system.	Industrial X-ray apparatuses Balances/hydraulic equipment Spectrographs Aircraft equipment Spectrophotometers Chromatographs Environmental measurement instruments	From Japan Storage Battery, establishes Dai Nippon Toryo Co., Ltd. and Nippon Yusoki Co., Ltd. Currently: Mitsubishi Nichiyu Forklift Co., Ltd.	Transferred to Kyoto Kagaku Co., Ltd. and other companies.
Heisei		Cardiovascular systems equipped with a direct-conversion flat panel detector	Life science related instruments Semiconductor related instruments		

Sales by Business Segment

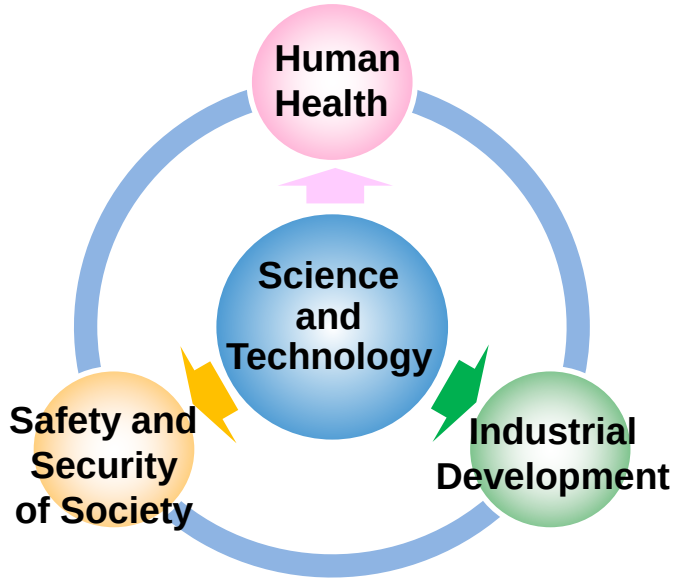
FY 2018 Net Sales

Business Segment	Value (M yen)	YoY Increase/ Decrease (%)	Ratio of Total Sales (%)
Analytical & Measuring Instruments Business	241,395	4.2	62
Medical Systems Business	69,084	4.8	18
Aircraft Equipment Business	27,343	-1.1	7
Industrial Machinery Business	45,419	2.8	11
Other Business	7,971	10.4	2
Total (Overseas ratio)	391,213 (197,307)	3.9 (4.5)	100 (50)



I. Shimadzu's History

B. Medium-Term Management Plan (Apr. 2017 to Mar. 2020)



Human Health

Support longer healthy life expectancy and provide appropriate healthcare, etc.

Safety and Security of Society

Conserve the natural environment, analyze food safety and aging infrastructure, etc.

Industrial Development

Support development of new materials and more energy efficient and lighter transport equipment, etc.

Targets for Final Year of Medium-Term Plan

FY 2019

- Net sales:
  400.0 billion yen or more
- Operating income:
  45.0 billion yen or more

Important Growth Fields	Main Topics
Healthcare	Healthcare, life sciences, pharmaceuticals, food safety, and functionally-enhanced foods
Infrastructure	Various infrastructure inspection, R&D, and manufacturing facilities
Materials	New materials, functionally engineered materials, and composite materials
Environment/Energy	Environmental measurement, regulatory compliance, renewable/hydrogen energy

I. Shimadzu's History

C. Strengthen Measures to Achieve SDGs

Distribution of Shimadzu Business Contribution to SDGs

SDGs to which Shimadzu Businesses Contribute Significantly

3 GOOD HEALTH AND WELL-BEING

GOOD HEALTH AND WELL-BEING

Example 1 Early Diagnosis and Treatment of Breast Cancer

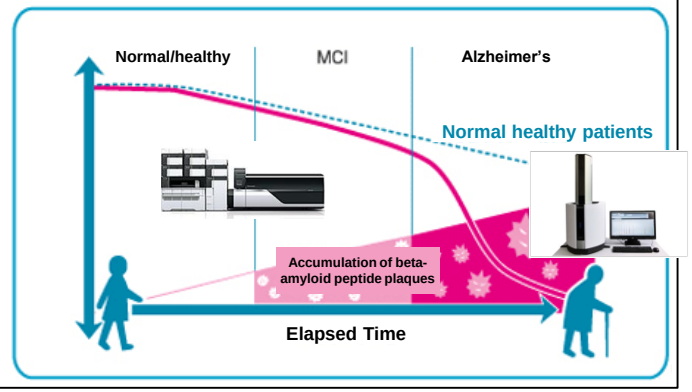
Elmammo
Dedicated Breast
PET System

LIGHTVISION
Near-Infrared
Fluorescence
Imaging System

Example 2 Measures to Prevent and Diagnose Dementia

Process before Alzheimer's Symptoms

Use of Mass Spectrometers



Shimadzu Corporation Research and Development Strategy

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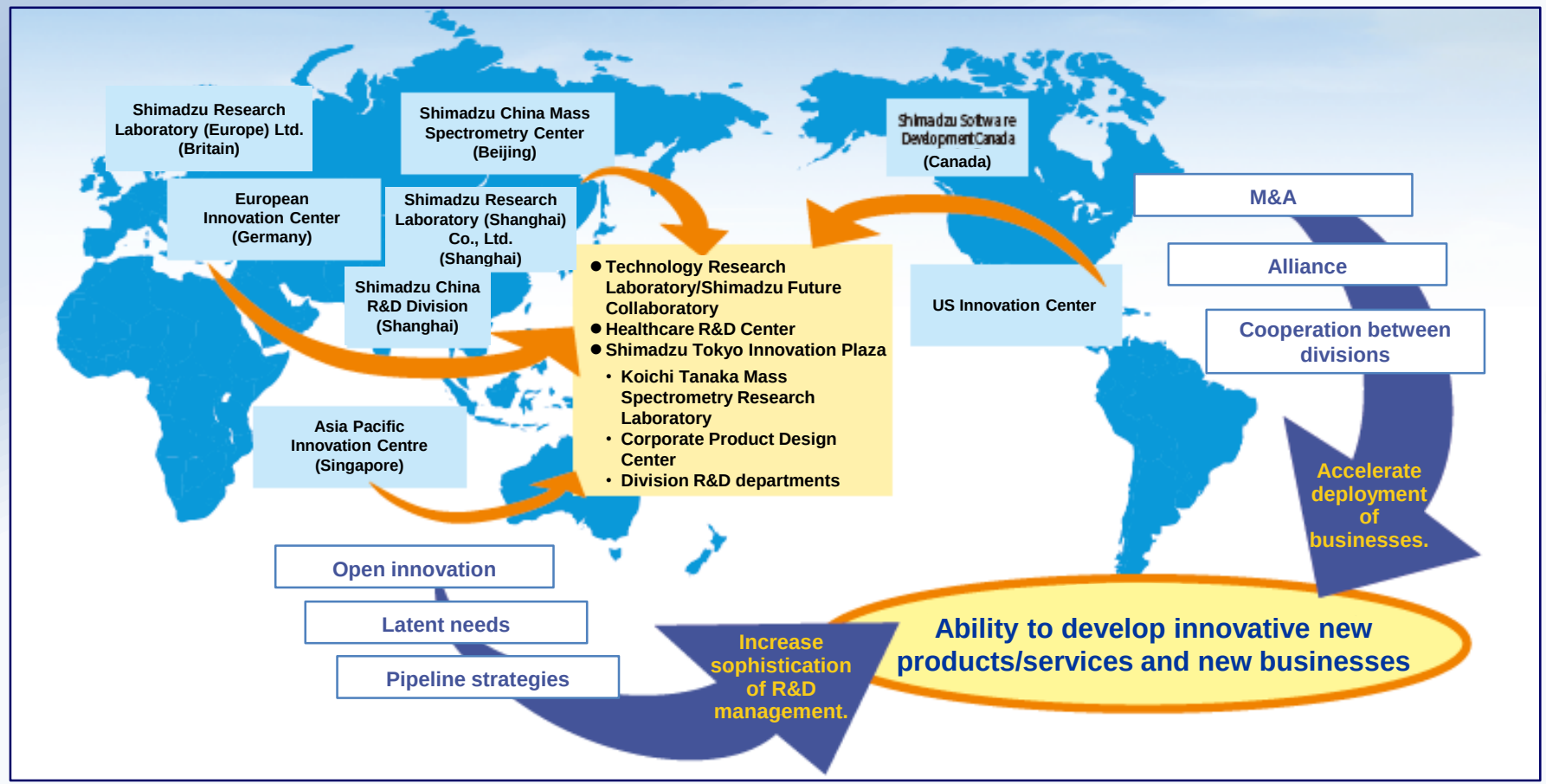
II. Shimadzu R&D Areas and R&D Strategy

A. Measures to Develop Advanced Technologies for Solving Challenges of Society

- Strengthen and expand/improve basic research, product/service development, and application technology/software functions.
- Engage in significantly strengthening research and development based on the medium-term management plan.
- Contribute to solving challenges of society using advancements in science and technology.



Contributing to Solving Challenges of Society Using Advancements in Science and Technology

- **Healthcare**
  Early detection of diseases, promotion of good health, etc.
- **Infrastructure**
  Development of safety systems, etc.
- **Materials**
  Evaluation of new material performance, etc.
- **Environment/Energy**
  Environmental monitoring, support for extending battery life, etc.

II. Shimadzu R&D Areas and R&D Strategy

B. Strengthen Research and Development Functions

Application Technology/Software Development

Japan
Tokyo Innovation Plaza
Scheduled for completion in December 2020

United States
Innovation Center

Europe
Innovation Center

China
Mass Spectrometry Center

Singapore
Innovation Centre

Instrument and Reagent Development

Integration of Analytical and Medical
Healthcare R&D Center

Division R&D Departments
Analytical/Medical/
Industrial/Aircraft

Alsachim in France
Develop reagents.

SSDC in Canada
Develop software.

Basic Research

Koichi Tanaka Mass Spectrometry Research Laboratory

Develop basic technologies for mass spectrometry.

Technology Research Laboratory

R&D of advanced core technologies

Corporate Product Design Center

Develop product design.

Technology Research Laboratory expanded (scheduled for completion in August 2020)

Shimadzu Research Laboratory (Europe) Ltd.

Develop basic technologies for mass spectrometry and X-ray photoelectron spectroscopy.

Shimadzu China R&D Division

Develop basic technologies for mass spectrometry.

Academia

Advanced companies

II. Shimadzu R&D Areas and R&D Strategy

C. New Facilities to be Opened in the Future

Basic Research

Shimadzu Future Collaboratory

Scheduled for completion in August 2020

Product/System Development

Healthcare R&D Center

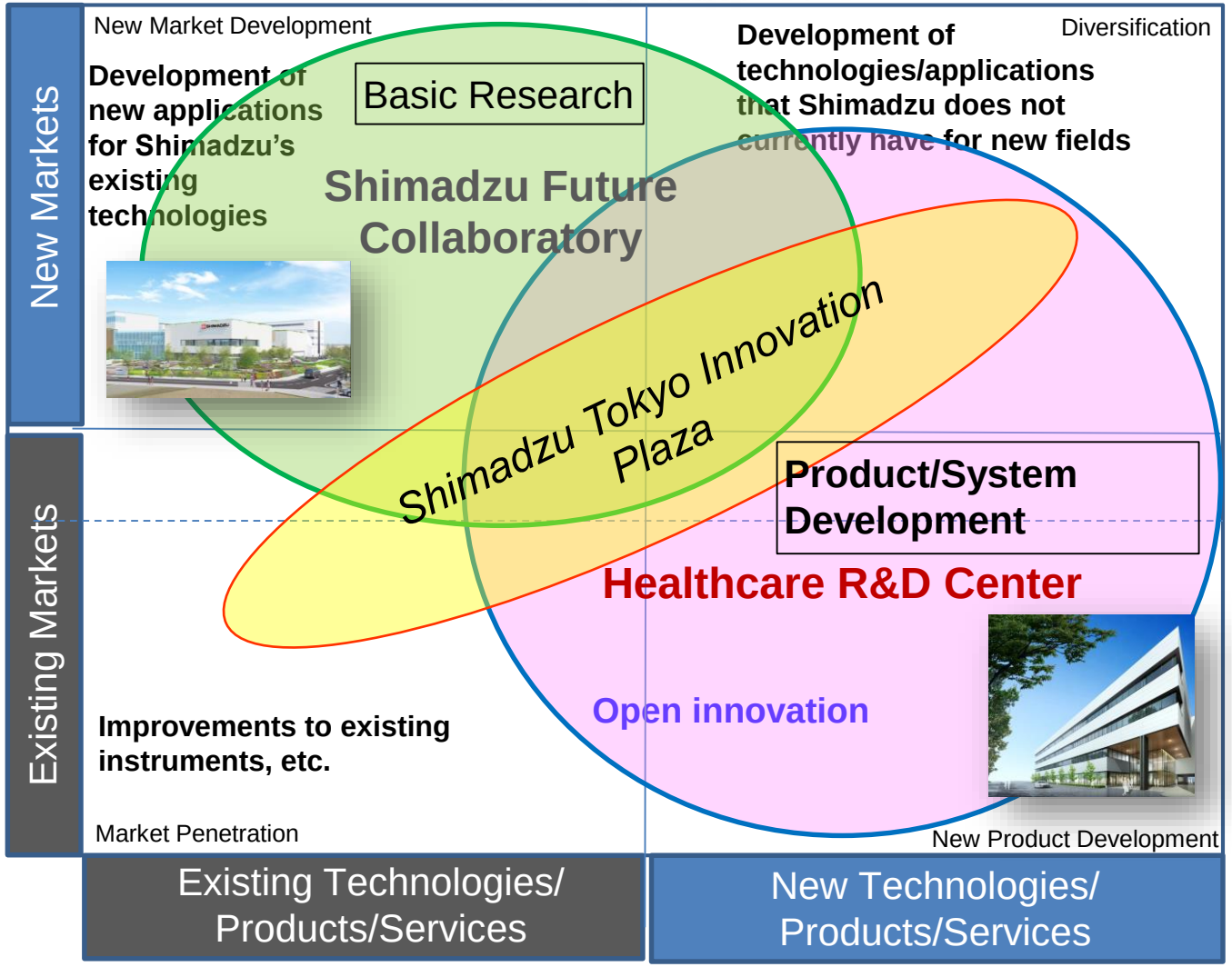
Opening ceremony June 4, 2019

Application Technology Development

Shimadzu Tokyo Innovation Plaza (tentative)

Scheduled for completion in December 2020

Note: By April 2021 (at beginning of second year in the next medium-term management plan), all new facilities for basic research, product development, and application technology development will be completed.



Shimadzu Corporation Research and Development Strategy

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III. Healthcare R&D Center

A. Overview of Healthcare R&D Center

- **The center will consolidate life science R&D departments in one location and promote a variety of joint research as an open innovation site.**
- **It will create major healthcare innovations and export many of them from Japan to the world.**
- **By implementing major healthcare research results in society, the center will contribute to achieving a better society through science and technology.**

Floor 1 Open innovation space for creating new value together with customers

Floors 2 to 4 Consolidates departments related to life sciences and promotes cooperation between Analytical and Medical businesses.

KYOLABS
Shimadzu's collaborative laboratories

Healthcare R&D Center
Building: Four above-ground floors
Floor area: 19,300 m^2
Completion: February 2019

III. Healthcare R&D Center

B. KYOLABS on First Floor of Healthcare R&D Center

- KYOLABS is a permanent joint research and development laboratory for promoting open innovation.
- It gathers wisdom from within and outside Shimadzu for creating revolutionary technologies, mainly in the healthcare field.

Floor 1

KYOLABS
Shimadzu's collaborative laboratories

Cooperative Laboratories—
Biochemistry laboratory

Cooperative Laboratories—
General chemistry laboratory

Interaction

This co-working space provides a relaxed atmosphere for interacting with others from within and outside Shimadzu.

Joint Development Laboratories—
Laboratory area

1. Joint Development Laboratories
(searching for new technological value)

2. Cooperative Laboratories
(includes eight independent laboratories)

Illustration of future

Exhibits and displays video of Shimadzu's core technologies and Shimadzu's vision for the future.

Joint Development Laboratories—Exhibition area

III. Healthcare R&D Center

C. Develop Advanced Technologies Based on Predictions of the Future

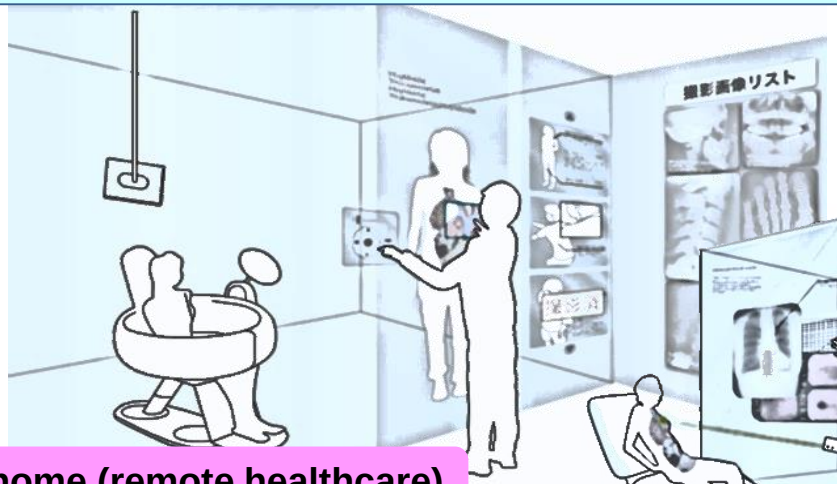
Innovation Example

Offer revolutionary products and services that integrate both analytical and medical technologies for a wide range of applications intended to maintain or improve human health.

Continuous measurement

Size-reduction technology

Wearable technology



Human-friendly consultation and examination rooms

AI technology

Data management technology

Sensing technology

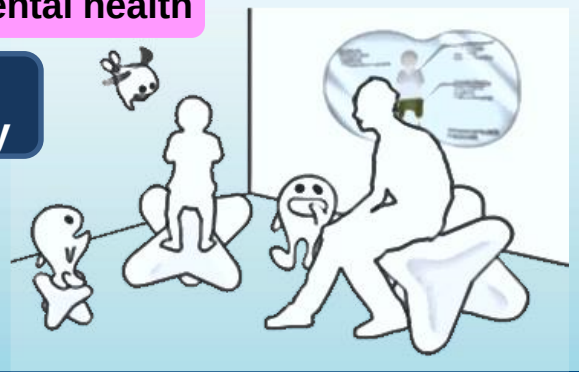
Increasing sensitivity

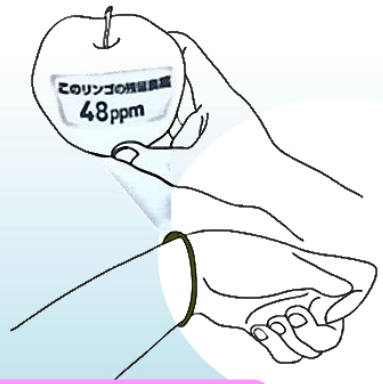
Consultation room at home (remote healthcare)

IoT technology

Caring for mental health

Robotics technology





Quickly identifying safe and delicious foods

III. Healthcare R&D Center

D. Examples of Research Topics at the Healthcare R&D Center

1. Joint Development Laboratories
Searching for New Technological Value

Field	Research Topic	Overview
Healthcare and Foods	Development of automatic pretreatment technology	Used for extracting target components by automated pretreatment using supercritical fluid, extracting food ingredients with functional properties, or searching for biomarkers. Pretreatment system used to configure fully automatic LCMS systems anticipated for the next generation of examinations
Bio	Omic analysis by mass spectrometer	Used for comprehensive analysis of metabolites, currently searching for practical applications in the smart-cell industry.
Healthcare and Neuroscience	Brain function research	Used for measuring brain cognition and motor functions with functional near-infrared spectroscopy imaging system (fNIRS).
Healthcare	Biomarker discovery by mass spectrometer	New mass spectrometer and data analysis method intended for biomarker discovery

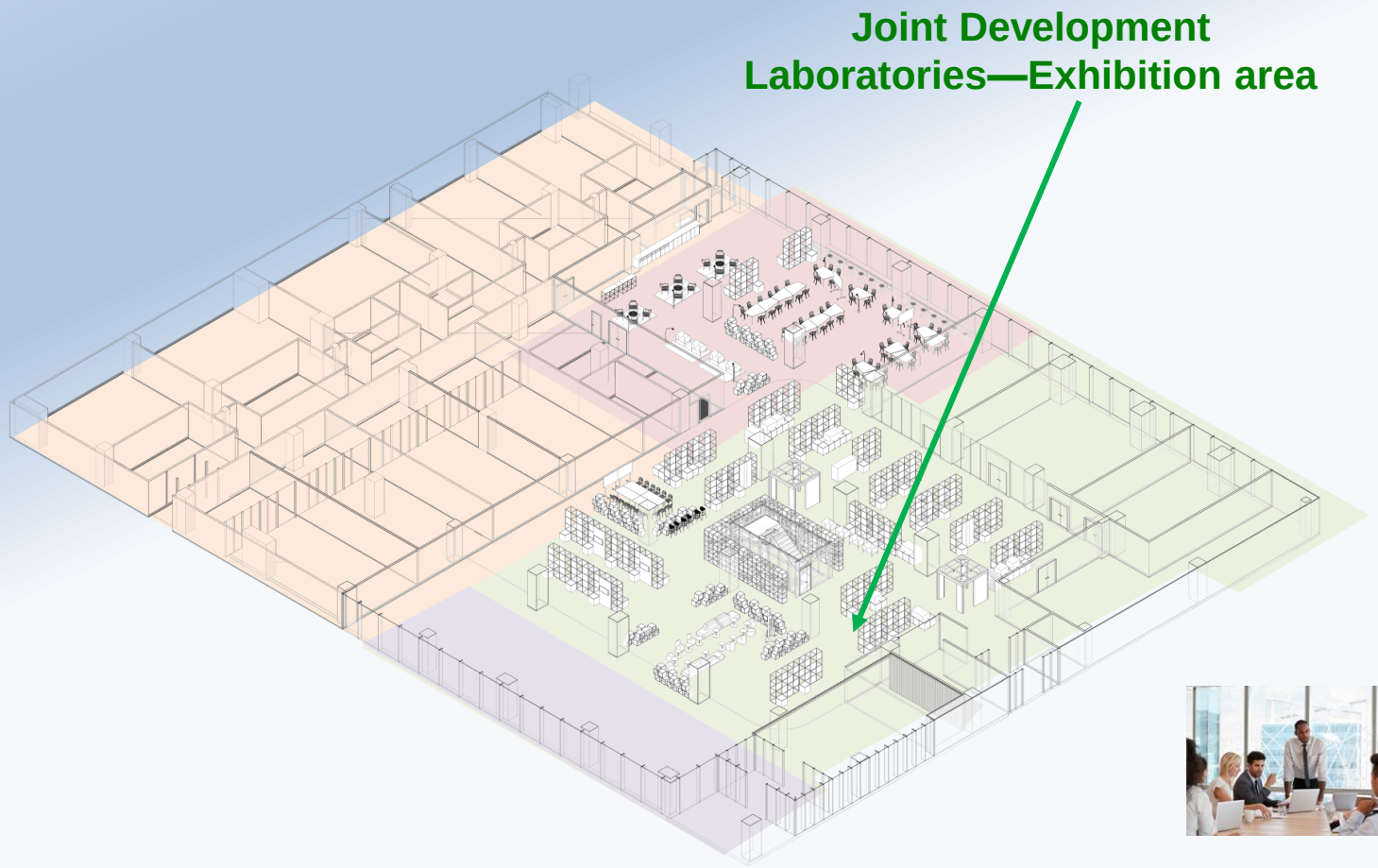
2. Cooperative Laboratories
Independent Laboratories Included

Field	Research Topic	Joint Research Organization	Overview
Healthcare and Cancer	More advanced early-stage cancer screening analysis system	Kobe University, National Cancer Center, etc.	Develops high-capacity online processing system.
Foods	Development of automatic pretreatment system	EU contract analysis companies	Automates and accelerates pretreatment for residual pesticide analysis.
Cells	Evaluation to demonstrate the potential of a next-generation cellular laboratory business	iPS Portal, Inc.	Builds drug discovery platform for iPS cells.

III. Healthcare R&D Center

D. Examples of Research Topics at the Healthcare R&D Center: Joint Development Laboratories—Exhibition Area

3. Joint Development Laboratories— Exhibition Area
Searching for New Technological Value



No.	Category
1	Advanced healthcare
2	Brain
3	Cells
4	Genes
5	Clinical Omics
6	Imaging
7	TOF-MS technology
8	Food safety and functionally-enhanced foods

III. Healthcare R&D Center

E. “Advanced Healthcare” Concept

- Supply products and services that offer new added value by integrating analytical measurement technology and medical imaging technology.
- Provide cross-organizational support for everything from daily health management to diagnostics, treatment, and prognosis management.

KYOLABS
Shimadzu's collaborative laboratories

Analytical & Measuring Technologies

Advanced Analytical & Measuring Instruments Technologies

- Chromatography systems
- Mass spectrometry systems
- Spectrometry systems
- Surface analysis/observation systems
- Life science related analytical systems

Advanced Medical Diagnostic Imaging Technologies

- Fluoroscopy systems
- Angiography systems
- General radiography systems
- PET systems
- Near-infrared imaging application systems

Medical Diagnostic Imaging Technologies

III. Healthcare R&D Center

F. New System Products Based on both Analytical and Medical Instruments (1)

An Integrated System that Displays both Medical Images and Mass Spectrometry Data in the Same Window

- Joint development with Tohoku University: Primary aldosteronism diagnosis and surgery
- Reduces the burden on patients by performing both the examination and surgery on the same day.
  → Conventionally, blood is acquired via a catheter and blood testing is outsourced before the surgery. Then the LCMS data is checked and surgery is performed one week later.

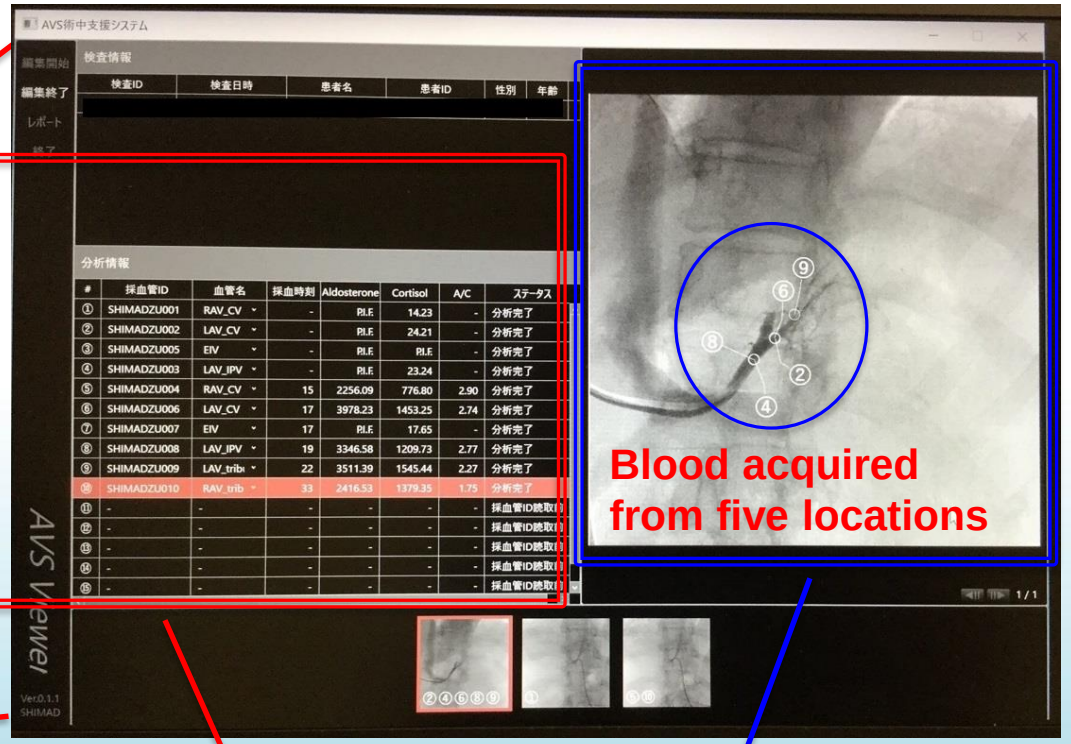
Medical: Angiography system

Image data

Analysis: LCMS

Mass spectrometry data (values)

Integrated Software Window



Data integration software (integrates medical imaging data with analytical mass spectrometry data)

Mass spectrometry data (values from multiple locations)

Medical image (blood acquired from multiple locations)

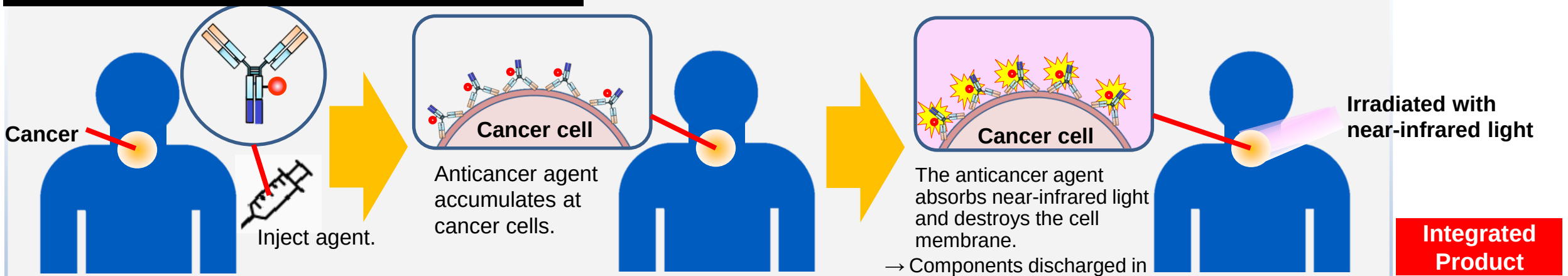
III. Healthcare R&D Center

F. New System Products Based on both Analytical and Medical Instruments (2)

Cancer Photoimmunotherapy: Joint Research with Dr. Hisataka Kobayashi at the National Cancer Institute (NCI) in the United States

- Cancer cells, with a drug attached, are destroyed by irradiation with near-infrared light.
- Unlike radiation therapy, anticancer drug treatment, or chemotherapy, it causes no patient harm (no radiation exposure or side effects).

Process Flow of Cancer Photoimmunotherapy



Integrated Product

Near-Infrared Imaging System for Surgical Support

Mass Spectrometer (MS)

Cancer Photoimmunotherapy System

III. Healthcare R&D Center

G. Overview of Advanced Healthcare Measures

- **Offer a series of various advanced healthcare products for applications from routine health management to diagnosis, treatment, and prognosis management.**
- **Build a total healthcare system for maintaining and improving health.**

Cancer

Lifestyle Diseases

Psychiatric Disorders

Treatment Systems

Total healthcare systems

Health management

Disease prevention

Routine Health Management	Ultra-Early Screening	Diagnostics	Medical Treatment	Prognosis Management
	Disease biomarkers (MS) (Genome information)	**Diagnostic imaging Molecular diagnostics** (Dedicated breast PET system) (MS)	**Cancer photoimmunotherapy** (Near-infrared fluorescence imaging system)	**Lymph node visualization during surgery** (Near-infrared fluorescence imaging system)
		Diagnostic imaging (X-ray systems)	**Support for blood acquisition from adrenal vein** (X-ray systems) (MS)	**Blood vessel visualization during surgery** (X-ray systems)
		Assessing improvements in mild cognitive impairments (Near-infrared light imaging)		

Disease biomarkers (MS) (Genome information)

Medication management (MS) (Genome information)

Rehabilitation therapeutic effect assessment (Near-infrared light imaging)

Advice report
(for individuals or business operators)

Health management advice system
Portal site for dementia prevention

AI

1. Next-Generation Examination Business | **2. Integrated Analytical-Medical Systems** | **3. Health Management Business**

III. Healthcare R&D Center

H. Advanced Life Science Systems (1):

Development of New Mass Spectrometry System

- **Using Shimadzu's unique digital ion trap technology (patented), a compact system was achieved with a small A3 size footprint and lighter 25 kg weight.**
- **Currently promoting new demand as the world's smallest MALDI-MS system.**
- **It is especially useful for analyzing biopharmaceuticals (such as antibody drugs) or for analyzing the structure of biological macromolecules, such as glycans or synthetic macromolecules.**

MALDI

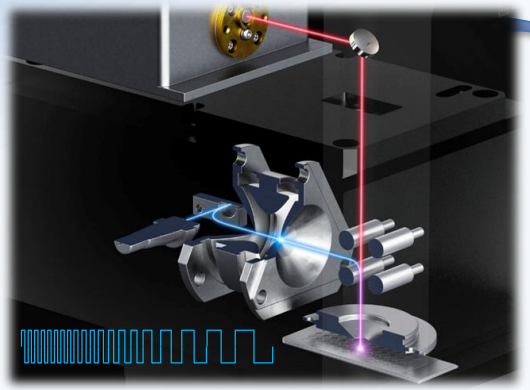
Matrix-Assisted Laser Desorption/Ionization

- High sensitivity
- High masses
- Efficient ionization of macromolecules

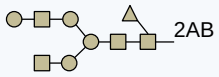
DIT

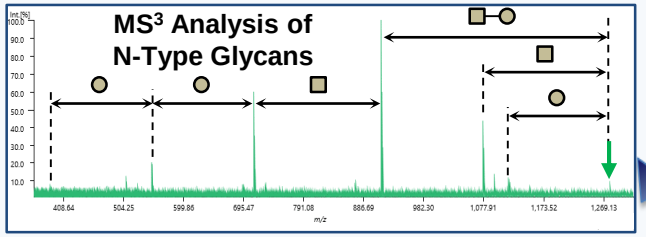
Digital Ion Trap

- Wide (high) mass range
- Sophisticated structural information (MS^n spectra)
- Small sized



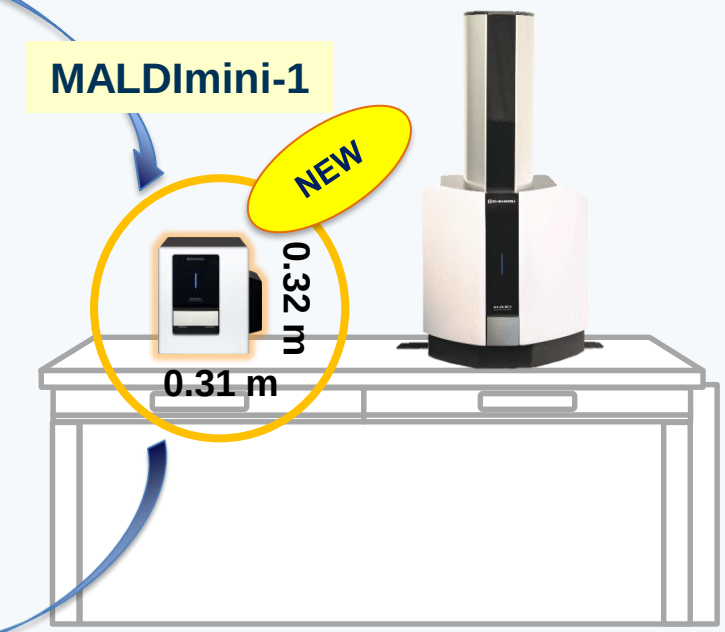
Digital Ion Trap Technology





MALDI-TOF MS
"MALDI-8020"

MALDI-TOF MS
"AXIMA" Series

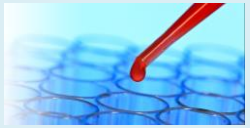
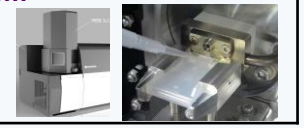


Compared to Size of Shimadzu MALDI Products

III. Healthcare R&D Center

H. Advanced Life Science Systems (2): Deploy Extensive Selection of Application Software

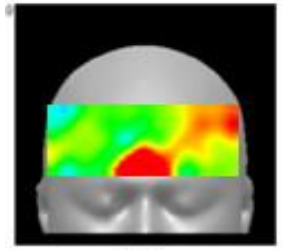
Shimadzu offers an extensive selection of application software and databases intended to improve user convenience.

• Foods 	GC/MS method package for residual pesticides in foods Ver. 2 	LC/MS/MS method package for residual pesticides Ver. 3 	LC/MS/MS method package for veterinary aminoglycoside antibiotics Ver. 2 	LC/MS/MS method package for mycotoxin 
• Environmental 	Smart Environmental Database 	Screening system for phthalate esters • Compliant with RoHS (II) Directive. 	LC/MS/MS method package for water quality analysis 	
• IVD 	Neonatal Solution Ver. 2.30 (neonatal metabolic disorders screening) 	DOSIMMUNE immunosuppressant analysis kit 		LabSolutions Insight multi-analyte quantitation support software 
• Pharmaceuticals  • Life science	Smart Metabolites Database 	LC/MS/MS method package for primary metabolites Ver. 2 	LC/MS/MS method package for lipid mediators Ver. 3 	LC/MS/MS method package for cell culture profiling 
• Toxicological drugs 	Quick-DB GC/MS and GC/MS/MS forensic toxicological database Ver. 2 	LC/MS/MS rapid toxicology screening system Ver. 2 	LC/MS/MS toxicological database 	DPiMS-8060 rapid toxicology screening system 

III. Healthcare R&D Center

H. Advanced Life Science Systems (3): Functional Near-Infrared Spectroscopy Imaging System

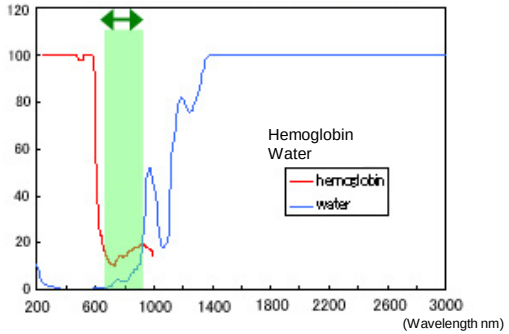
(1) Uses near-infrared light that is safe for biological organisms.
(2) Measures relative variations in hemoglobin as they vary due to neural activity in the cerebral cortex.
(3) Results can be displayed in real time, as a trend graph or image.



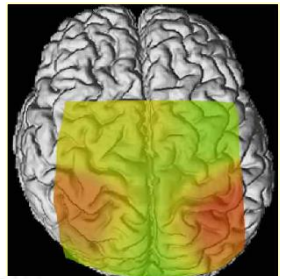
Conversation

Silence

Window to the body: Wavelength range that penetrates the body easily

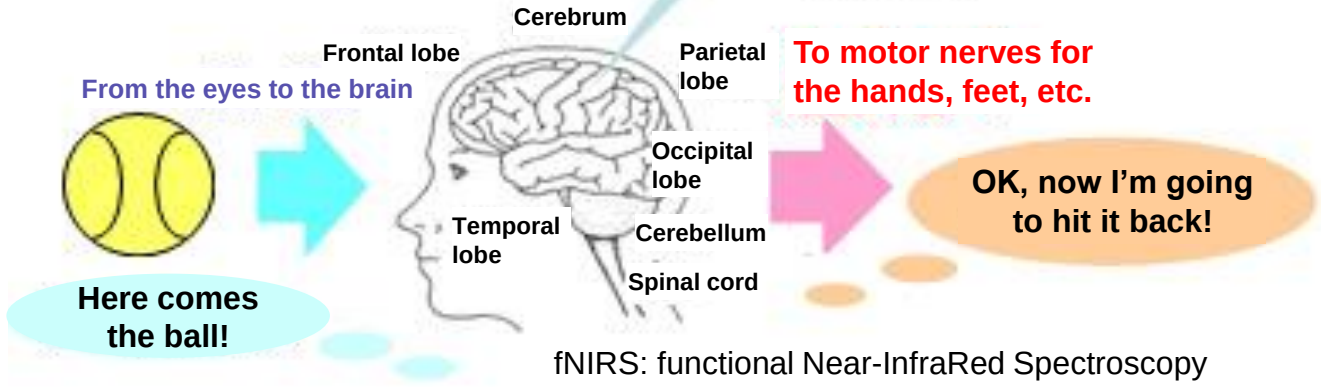


Absorption Rate of Water and Hemoglobin



Evaluating Brain Function

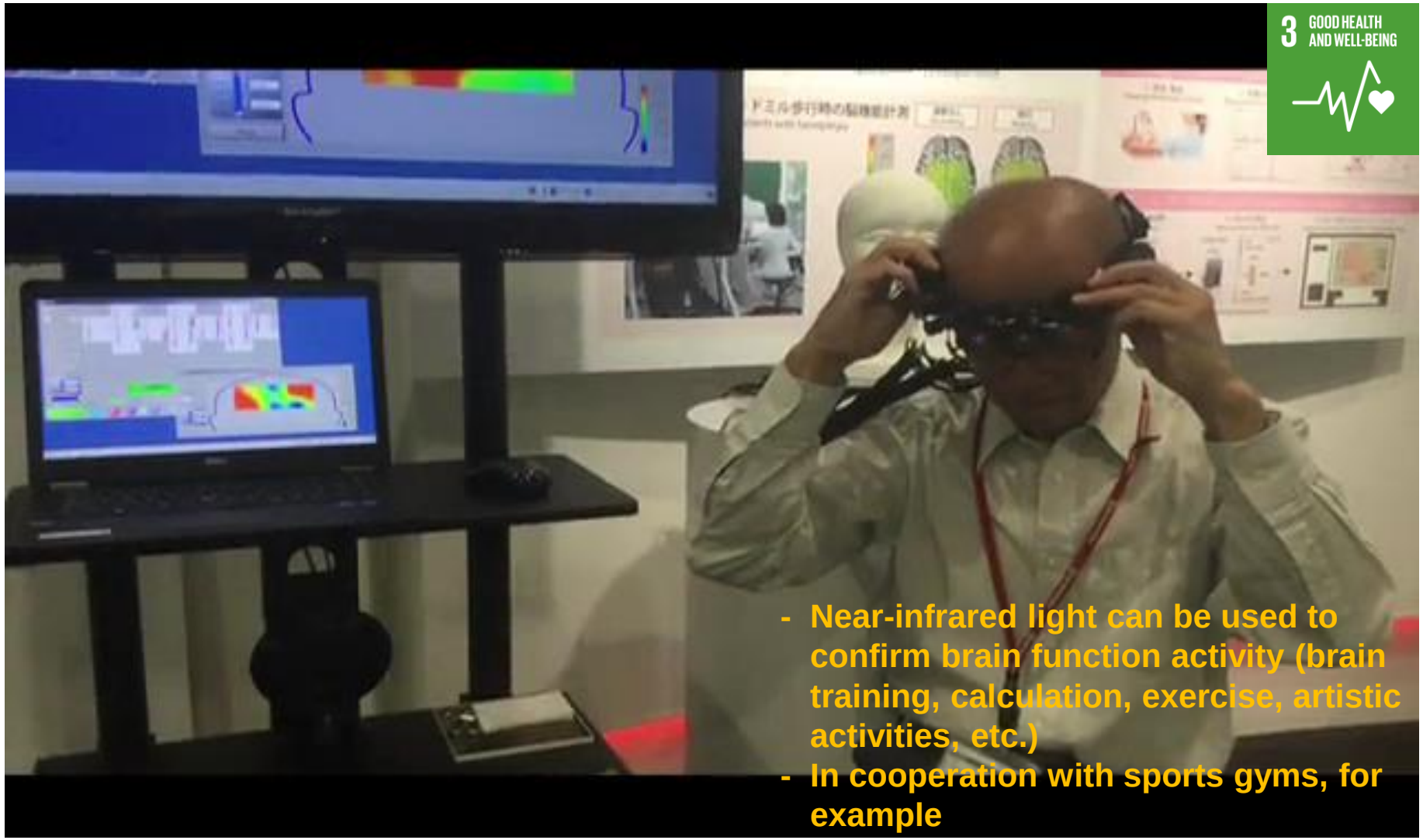
About 100 billion neurons



fNIRS: functional Near-InfraRed Spectroscopy

III. Healthcare R&D Center

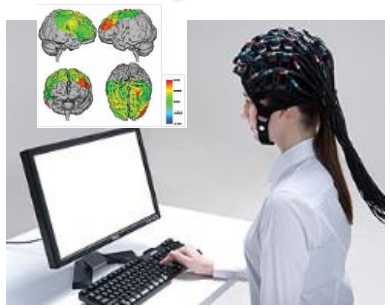
H. Advanced Life Science Systems (4): Functional Near-Infrared Spectroscopy Imaging System



- Near-infrared light can be used to confirm brain function activity (brain training, calculation, exercise, artistic activities, etc.)
- In cooperation with sports gyms, for example

MCI blood test

Intervention and prevention service



Confirmation of recovery level and prevention of cognitive disorders

Shimadzu Corporation Research and Development Strategy

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III. Summary

Comprehensively Strengthen Technical Capabilities, Starting with Product Development and Basic Research, Followed by Application Development

- After the Healthcare R&D Center, expand/improve the Technology Research Laboratory, and plan the construction of a new Tokyo Innovation Plaza.
- Comprehensively make significant improvements to technical capabilities, starting with product development and basic research, followed by application development.
- At each research institution, engage in open innovation more actively and strive to create innovative results.

Promoting Development of Products/Services and New Businesses

Healthcare R&D Center (within Sanjo Works in Kyoto City)

Consolidates life science engineering departments in one location. Provides a joint research environment and promotes collaboration with academia, corporations, or other advanced partners in various different fields. Also enables closer cooperation between Analytical & Measuring Instruments and Medical Systems segments and creates new added value. Completed in February 2019.

Strengthening Basic Research

Technology Research Laboratory/Shimadzu Future Collaboratory (Seika-cho, Kyoto)

Significantly expands/improves development function for basic research fields. Also pursues developing advanced technologies, such as the five senses, innovative biotech, and AI. Also actively engages in open innovation. Scheduled for completion in August 2020.

Accelerating Application Technology/Software Development

Tokyo Innovation Plaza (Inside the King Skyfront in Kawasaki City, in Kanagawa Prefecture)

Promotes development of advanced analytical techniques and applications. Takes advantage of being near central Tokyo and Haneda Airport and even utilizes the Plaza for international exchanges between researchers. Scheduled for completion in December 2020.

III. Summary

Cooperation with Regional Governments and Contribution to Rebuilding in Rural Regions

■ Kyoto Prefecture

- ✓ In March 2019, partnered with Kyoto Prefecture for creating an innovative city.
- ✓ Promotes cooperation on ten projects, such as Research and Development of Technology for Brain Function Analysis at Keihanna Academic Research City.

Partnership Signing Ceremony in March 2019
Right: Governor Nishiwaki of Kyoto Prefecture
Left: Shimadzu President Ueda

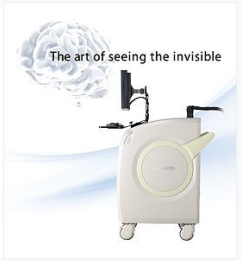
■ Yamaguchi Prefecture

- ✓ In December 2018, partnered with Yamaguchi University, in Yamaguchi City, Yamaguchi Prefecture, based on the topic of managing health.
- ✓ Promotes research on reducing the risk of dementia with help from medical institutions in the prefecture and citizen monitors.

Partnership Signing Ceremony in December 2018
From the left is Yamaguchi University President Oka, Shimadzu President Ueda, Yamaguchi Prefecture Governor Muraoka, and Yamaguchi City Mayor Watanabe.

■ Miyazaki Prefecture

- ✓ In 2015, Shimadzu jointly established a Food Research Organization with Miyazaki Prefecture.
- ✓ Promotes measures to increase the added value of foods, such as by developing a method for simultaneously analyzing residual pesticide components and analyzing components in foods with functional properties.
- ✓ In March 2019, the research was awarded the First Japan Open Innovation Prize from the Minister of Agriculture, Forestry and Fisheries.



SHIMADZU

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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.