

# **Contributing through Science and Technology- Collaboration Between Osaka University and Shimadzu**

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Senior Manager, Shimadzu Corporation  
Guest Professor  
Osaka University Shimadzu Analytical  
Innovation Laboratory**

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# Shimadzu Corporate Outline

**Corporate Philosophy:** Contributing to Society through Science and Technology

**Management Principle:** Realizing Our Wishes for the Well-being of both Mankind and the Earth

**Established:** March, 1875 

**Formation of Limited Company:** September, 1917

**Capital:** 26.6 Billion Yen

**Consolidated Sales:** 314.7 Billion Yen

**Number of Employees:** 3,154 (Japan)

10,879 (Group)

**Consolidated Subsidiaries:** 74 (25 in Japan, 49 Overseas)



(As of March 31, 2015)

# Shimadzu History (1)

1875 Genzo Shimadzu Sr. started the manufacture of physical and chemical instruments for educational purposes in Kiyamachi-Nijo, Kyoto.



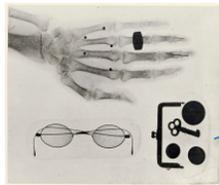
Founder Genzo Shimadzu Sr.



Successor Genzo Shimadzu Jr.

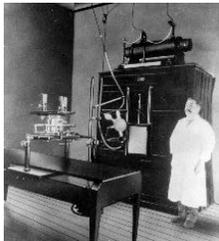
1877 Succeeded in Japan's first manned balloon flight.

1896 Succeeded in taking radiographs.



1897 Started the manufacture of storage batteries.

1909 Built Japan's first medical X-ray apparatus.



1956

He was a craft man to make and repair Buddhist altar articles.

1961

He learned physical and chemical experiments at a public institute near his house and

1968

1975

started the manufacture of physical and chemical instruments for educational purposes according to requests of the

1979

1989

He worked with Kyoto University (founded in 1897) and kept challenging various new themes.

Succeeded in taking radiographs after 11 months from the discovery of the X ray by Dr. Roentgen.



R. Germany.

# Shimadzu History (2)

**Koichi Tanaka awarded Nobel Prize in Chemistry**

- 1991 Established Keihanna Research Laboratory  
Established Hadano Works.
- 1992 Established Beijing Shimadzu Medical Equipment Co., Ltd. in China.
- 1994 Established Tianjin-Shimadzu Hydraulic Equipment Co., Ltd. in China.
- 1996 Established Shimadzu Philippines Manufacturing, Inc.
- 1997 Established Shimadzu Vietnam Medical Hi-Tech Company Ltd.  
Established Shimadzu U.S.A. Manufacturing, Inc.

- 2002 Koichi Tanaka awarded Nobel Prize in Chemistry and Japan's Order of Cultural Merit.
- 2005 Established Shimadzu Analytical (India) Pvt. Ltd.
- 2006 Established Shimadzu Medical (India) Pvt. Ltd.
- 2007 Established Shimadzu Middle East & Africa FZE in UAE (Dubai).
- 2008 Took over Mitsubishi Heavy Industries' turbomolecular pump business.

(Hong Kong) Ltd.  
(Suzhou) Instruments  
in China.



# Shimadzu History (3)

2011 Established Shimadzu South Africa (Pty) Ltd. in South Africa.

Established Shimadzu Korea Vacuum Equipment Co., Ltd. and Dong-il Shimadzu Corporation in Korea

2013 Established Shimadzu Latin America S.A. in Uruguay.

Established Shimadzu Scientific Instruments (Taiwan) Co., Ltd.

2014 Established Shimadzu Malaysia Sdn. Bhd.



# Analytical Instruments



**Gas Chromatograph-Mass Spectrometers**



**Total Organic Carbon Analyzers**



**Scanning Probe Microscopes**



**Microchip Electrophoresis Systems**



**Liquid Chromatograph-Mass Spectrometers**



**Ultra High Performance Liquid Chromatographs**



**Spectrophotometers**

# Medical Systems



**Angiography Systems**



**General Radiography Systems**



**Fluoroscopy Systems**

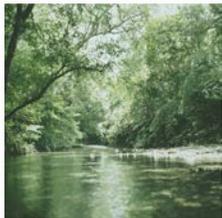


**Digital Mobile X-Ray Systems**

and Aircraft Equipment, Testing and Measuring Instruments, Industrial Equipment-  
industrial machinery, hydraulic equipment and device components

# Key Business Segments Major Markets

Shimadzu's science and technology supports various areas of society.



## Environment

- Analysis and measurement of atmosphere, water, and soil
- Analysis of emissions and waste substances



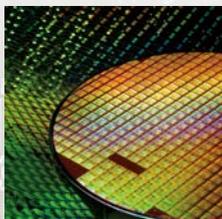
## Medicine

- Analysis and evaluation at development process
- Support for the quality control
- Support for the control of production facilities



## Medical Care

- Support for the diagnostic treatment at medical institutions
- Research & development of new medicines



## Semiconductor / Electronics

- Semiconductor production process
- Displays production process



## Transport

- Safety flight of airplane and comfortable passenger environment
- Evaluation tests for automobile safety and comfort
- Power source for industrial vehicles and construction machinery



## Food

- Characteristic evaluation and component analysis of raw materials
- Safety evaluation
- Flavor and texture measuring tests



## Energy

- Higher efficiency of solar panels
- Analysis and evaluation in developing next-generation batteries (Solar panel and lithium ion batteries)



## Material

- Analysis and evaluation of oil chemical products and new materials
- Analysis and evaluation of metal, glass, and ceramic materials

# Research & Development Organization



# Activities to Contribute to Society

Awards for Outstanding Research  
(Japan and China)



Support for Global Environmental Protection Activities  
United Nations University Environmental Monitoring Project



Training Two Students from Vietnam National  
University at the GADC  
Shimadzu A. Nakamoto Scholarship



Promoting Planting Trees Around the World  
Shimadzu Corporation Forest Project



Educating Elementary and Junior High School  
Students About the Environment  
On-Site Lectures



Educating Young People  
Shimadzu Hands-On Analysis School



Shimadzu appreciates ESG (Environmental, Social, Governance)

# Collaboration between Osaka University and Shimadzu



# Collaboration with Prof. Fukusaki

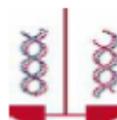
In 2008, Collaboration started



GCMS-QP2010Ultra gave good results  
Compatible or superior results to de-facto STD, GC-TOF



[www.elsevier.com/locate/jbiosc](http://www.elsevier.com/locate/jbiosc)



Journal of Bioscience and Bioengineering  
VOL. 112 No. 3, 292 – 298, 2011



## Practical non-targeted gas chromatography/mass spectrometry-based metabolomics platform for metabolic phenotype analysis

Hiroshi Tsugawa,<sup>1</sup> Takeshi Bamba,<sup>1</sup> Masakazu Shinohara,<sup>2</sup> Shin Nishiumi,<sup>3</sup>  
Masaru Yoshida,<sup>2,3,4</sup> and Eiichiro Fukusaki<sup>1,\*</sup>

*Department of Biotechnology, Graduate School of Engineering, Osaka University, 2-1 Yamadaoka, Suita, Osaka 565-0871, Japan,<sup>1</sup> The Integrated Cell Mass Spectrometry, Kobe University Graduate School of Medicine, 7-5-1 Kusunoki-Cho, Chu-o-ku, Kobe, Hyogo 650-0017, Japan,<sup>2</sup> Division of Gastroenterology, Kobe University Graduate School of Medicine, 7-5-1 Kusunoki-Cho, Chu-o-ku, Kobe, Hyogo 650-0017, Japan,<sup>3</sup> and Division of Metabolomics Research, Kobe University Graduate School of Medicine, 7-5-1 Kusunoki-Cho, Chu-o-ku, Kobe, Hyogo 650-0017, Japan<sup>4</sup>*

Received 14 March 2011; accepted 2 May 2011  
Available online 8 June 2011



# Mission of the Joint Laboratory

To develop new technologies for metabolomics data analysis systems and to research new operating methods to utilize and apply Metabolomics to various fields such as medical, food science and pharmaceutical, as Metabolomics has attracted considerable interest as a promising means of understanding fundamental biology and elucidating the function of genes with unknown functions.



Osaka University Shimadzu

Analytical Innovation Research Laboratory

# Objective of the Joint Laboratory

Osaka University, Fukusaki Laboratory

Top researcher for development of Metabolomics methodologies and applications

Having the cutting-edge technologies and ample experiences in sample pre-treatment, measurement and data analysis

Shimadzu Corporation

Willing to satisfy the unmet Metabolomics needs by using its abundant knowledge and experiences through many years development of separation technologies and mass spectrometry

**Technologies**

**Technologies**

Osaka University provides “Joint Laboratory” scheme where university and private companies work together for solutions of common issues.

Joint Laboratory

Open Innovation Base

# Members of the Joint Laboratory

## Osaka University

Dr. Eiichiro Fukusaki

Mentor Professor [Laboratory of Bioresources Engineering (Metabolomics)]

Dr. Syuichi Simma

Associate Professor

Dr. Masahiro Kino-oka

Professor [BioProcess Systems Engineering]

Dr. Kazuhito Fujiyama

Professor [Applied Microbiology Laboratory]

Dr. Takeshi Bamba

Guest Professor [Professor of Kyusyu University, Medical Institute of Bioregulation]



## Shimadzu Corporation

Dr. Junko Iida

Guest Professor;  
Senior Manager, Life Science Business Department

Mr. Takanari Hattori

Guest Researcher  
Global Applications Development Department



The large and important and very much discussed question is: How can the **events in space and time** which take place within the spatial boundary of a living organism be accounted for by physics and chemistry?

*“What Is Life ?~The Physical Aspect of the Living Cell~ ”*

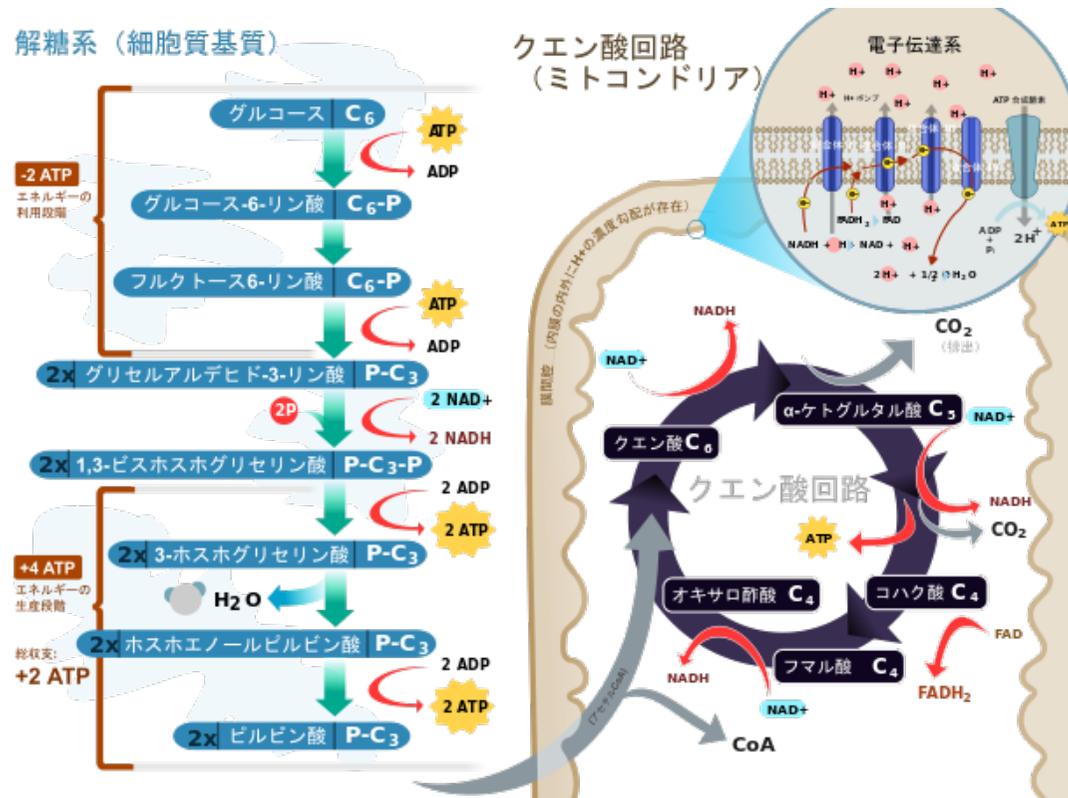


**Dr. Erwin Schrödinger**

# Proposing Metabolomics solutions

## Living organism acts dynamically and changes over time

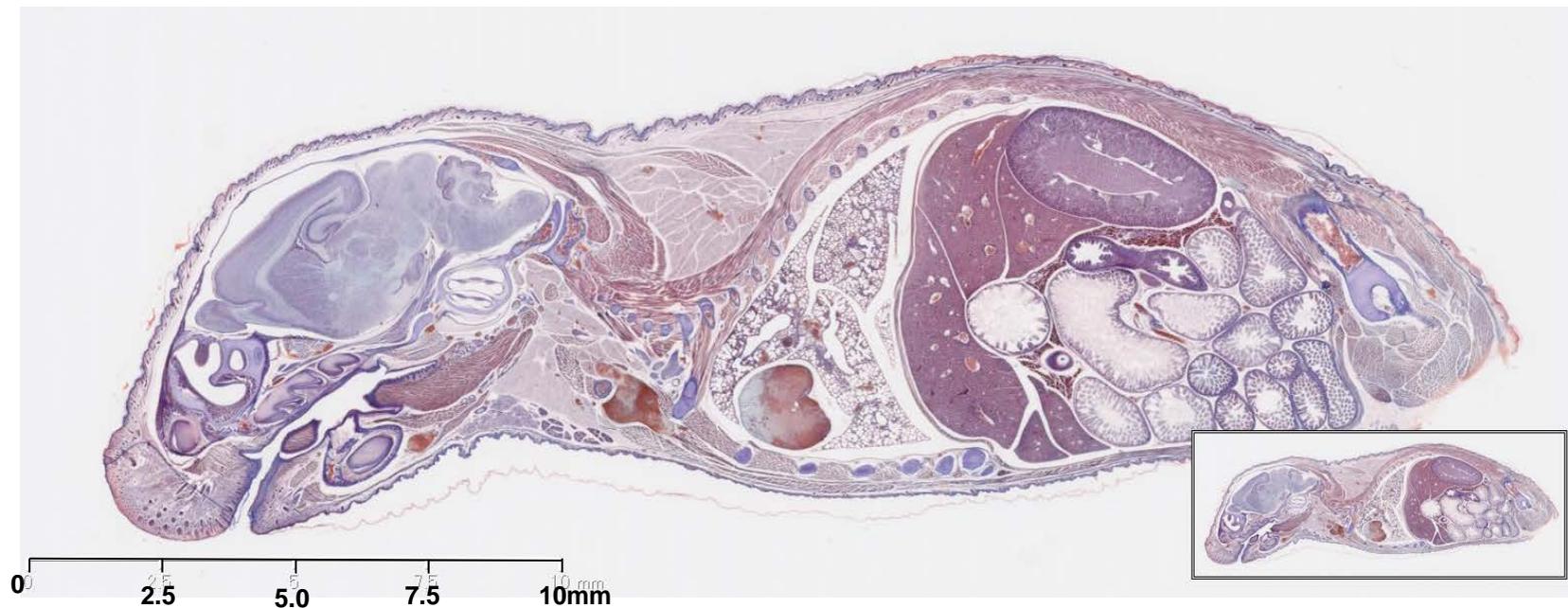
We have to know the amounts of substances at a specific time.



# Proposing Metabolomics solutions

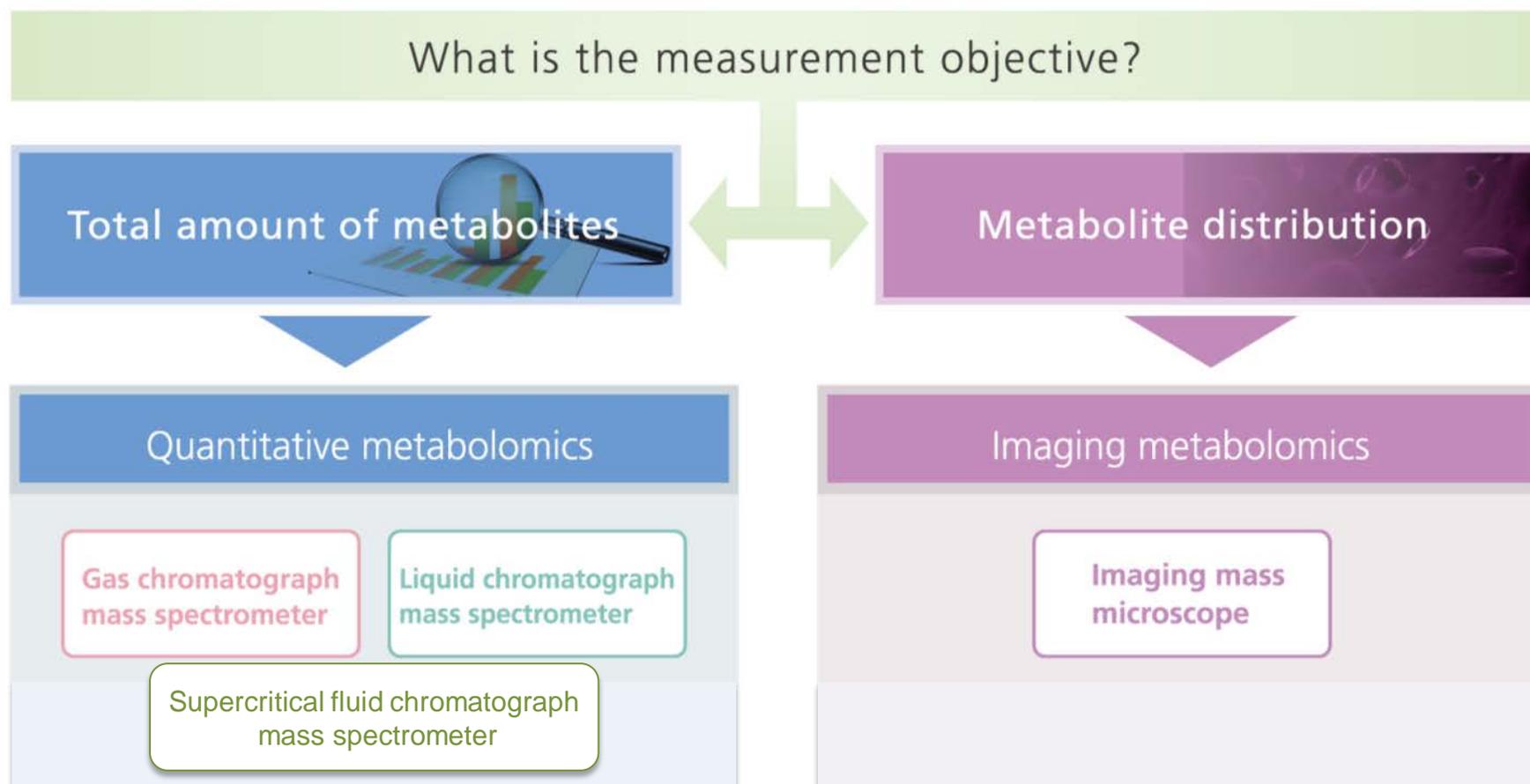
## Metabolites distribution has its meaning

We have to know the amounts of substance at a place and space.



# Shimadzu “Metabolomics” Solution

We are proposing “Quantitative Metabolomics” to determine amounts of metabolites and their changes, and “Imaging Metabolomics” to measure metabolites’ distribution, in order to unravel various phenomena of “life”



# Quantitative Metabolomics Solution

## GC-MS(/MS)



Measure more than hundreds  
 First choice of Comprehensive  
 measurements(Widely targeted).  
 -> Gold standard  
 stability.

Established the method for  
 sample prep. and analytical  
 condition.(Easy operations)

## LC-MS(/MS)



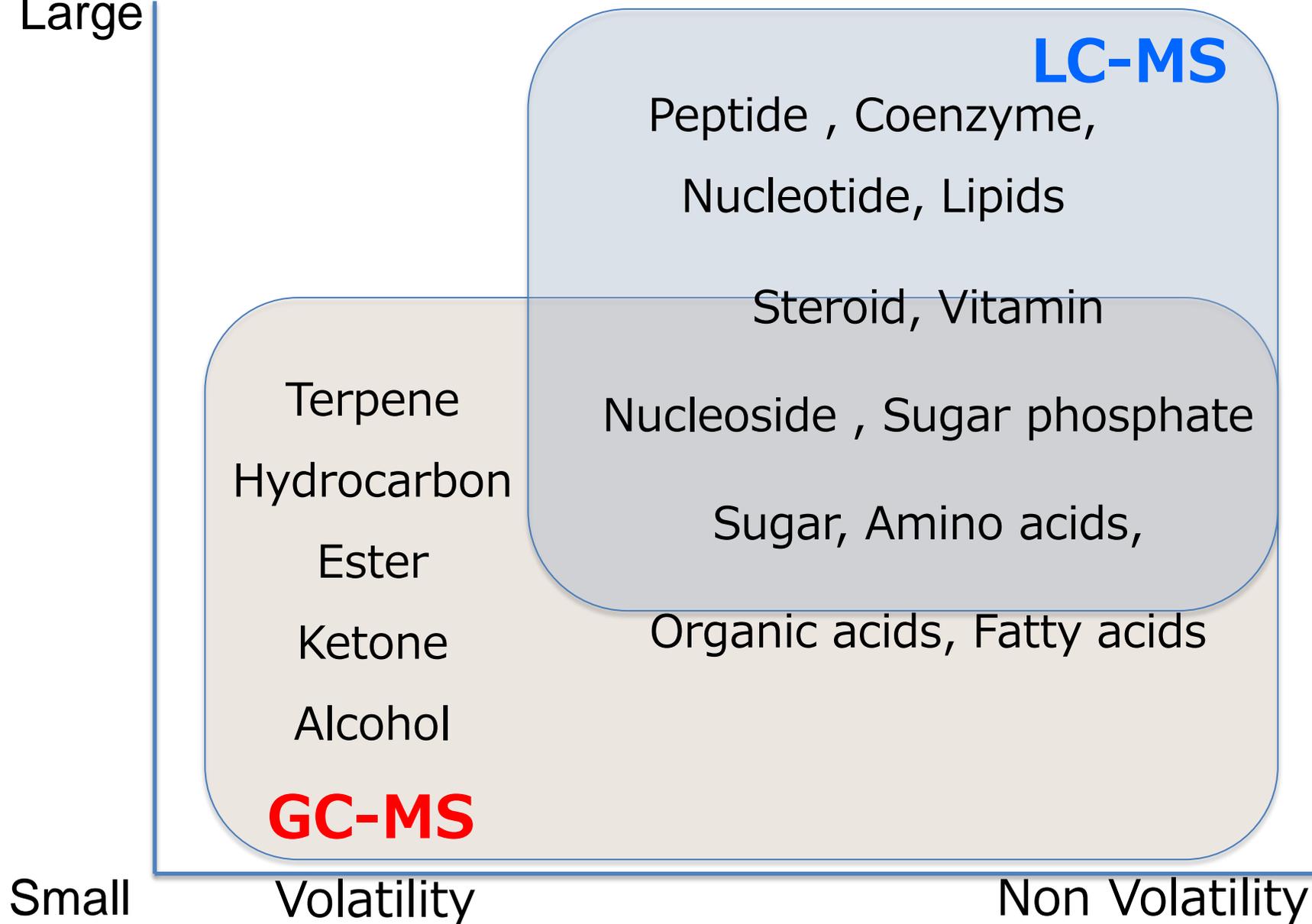
Measure less than 100 targeted  
 Routine for targeted  
 metabolites.(Less than 100 meta.)  
 Reduce the analysis time  
 including sample preparation.

Measure a wide range of  
 metabolites by changing  
 analytical conditions.

# Quantitative Metabolomics

## - target compound guideline

M. W. Large



# Quantitative Metabolomics

## - target compound guideline

M. W. Large



Supercritical Fluid  
Extraction/  
Chromatography  
Nexera UC



Unified  
Chromatography

Small

**SFC-MS**

Terpene  
Hydrocarbo  
Ester  
Ketone  
Alcohol

**GC-MS**

Volatility

**LC-MS**

Peptide , Coenzyme,  
Nucleotide, Lipids

Steroid, Vitamin

Nucleoside , Sugar phosphate

Sugar, Amino acids,

Organic acids, Fatty acids

Non Volatility

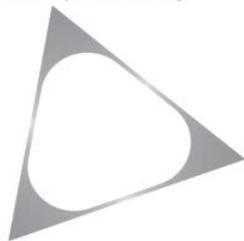
# Imaging Metabolomics Solution



Imaging Mass Microscope

iMScope *TRIO*

Imaging Mass Spectrometry



Qualitative Analysis

Optical Microscope

## 1. Integrated MS imaging system

-Embodiment market needs

Highest spatial resolution MS imaging, less than 5 $\mu$ m,  
with High speed analysis

Offers easy-to-set parameters and extensive image analysis functions.

## 2. Integrates optical images

-Top rank of market needs and competition

Minute area observation and analysis with microscope

Direct analysis from Fluorescent observed sample

## 3. Quantitative analysis

-Feature of IT-TOF-

Structural analysis using highly accurate MS<sup>n</sup> (n $\leq$ 10 )

MS/MS imaging increase Sensitivity than MS image

Connect LC \* increase Sensitivity and accuracy

Developed jointly with Hamamatsu University School of Medicine and Keio University using a JST Prototype Validation/Practical Realization Program for Advanced Measurement and Analysis.

# Joint Laboratory's View

iMScope

Nexera UC  
on line SFE/SFC

Nexera+LCMS-8060 (behind the pillar)

GCMS-TQ8040



GCMS-QP2010 Ultra

LCMS-8050

Nexera+LCMS-8040

**Regenerative medicine**

**Innovative drug development**  
**Diagnostics treatment**

**Ultra-early diagnostics**

**Preemptive Medicine**  
**Not disease**

Foods  
Functional foods

**Healthcare**



# Design the Future

- Best for Our Customers -