

BEANS[®]

Hetero-functional Integrated Device Technology Development



Bio Electro-mechanical Autonomous Nano Systems

BEANS Laboratory
The University of Tokyo
Kyushu University
Ritsumeikan University
Advanced Industrial Science and Technology



BEANS Project is sponsored by NEDO (New Energy and Industrial Technology Development Organization)

MEMS Future = BEANS¹

- In Japan, we say semiconductor chips are rice for the industry.
- Rice provide energy for the body.

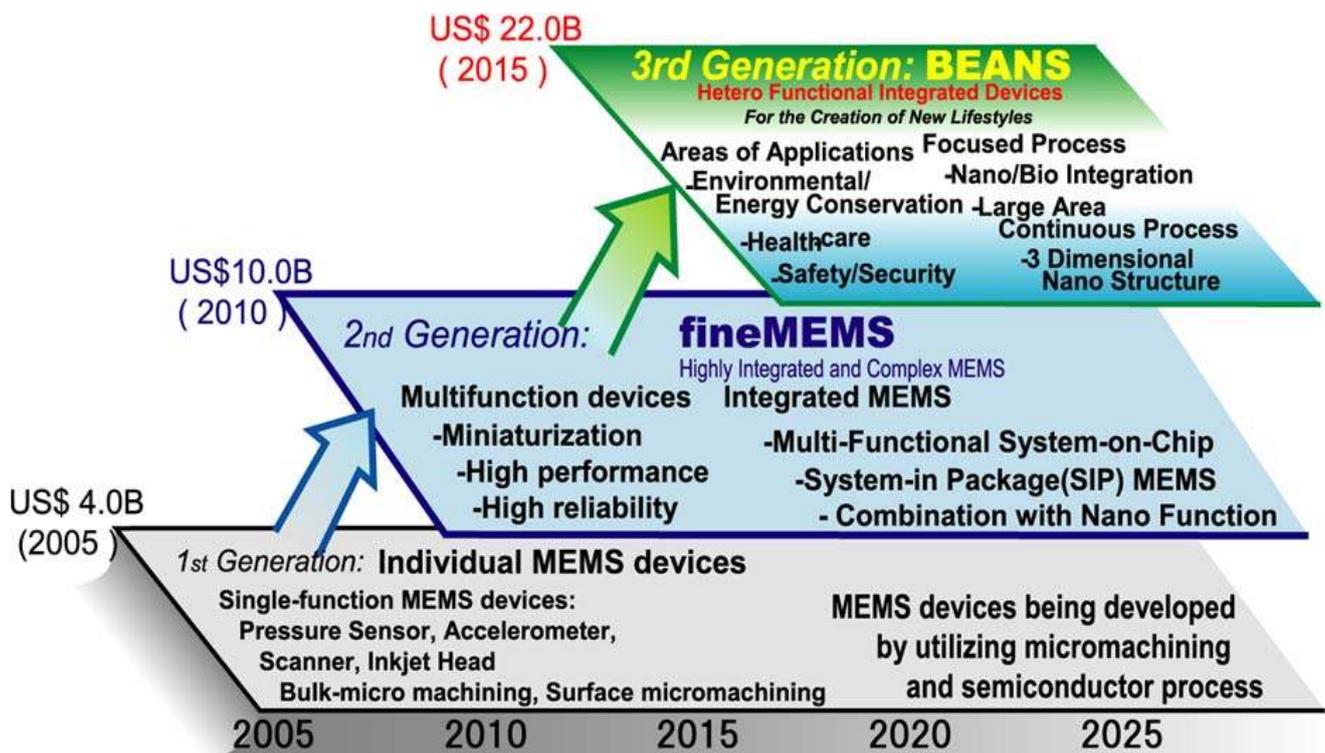


- Beans contain proteins for bio functions, such as eyes for sensing and muscle for actuation. We hope MEMS to be beans for the industry.

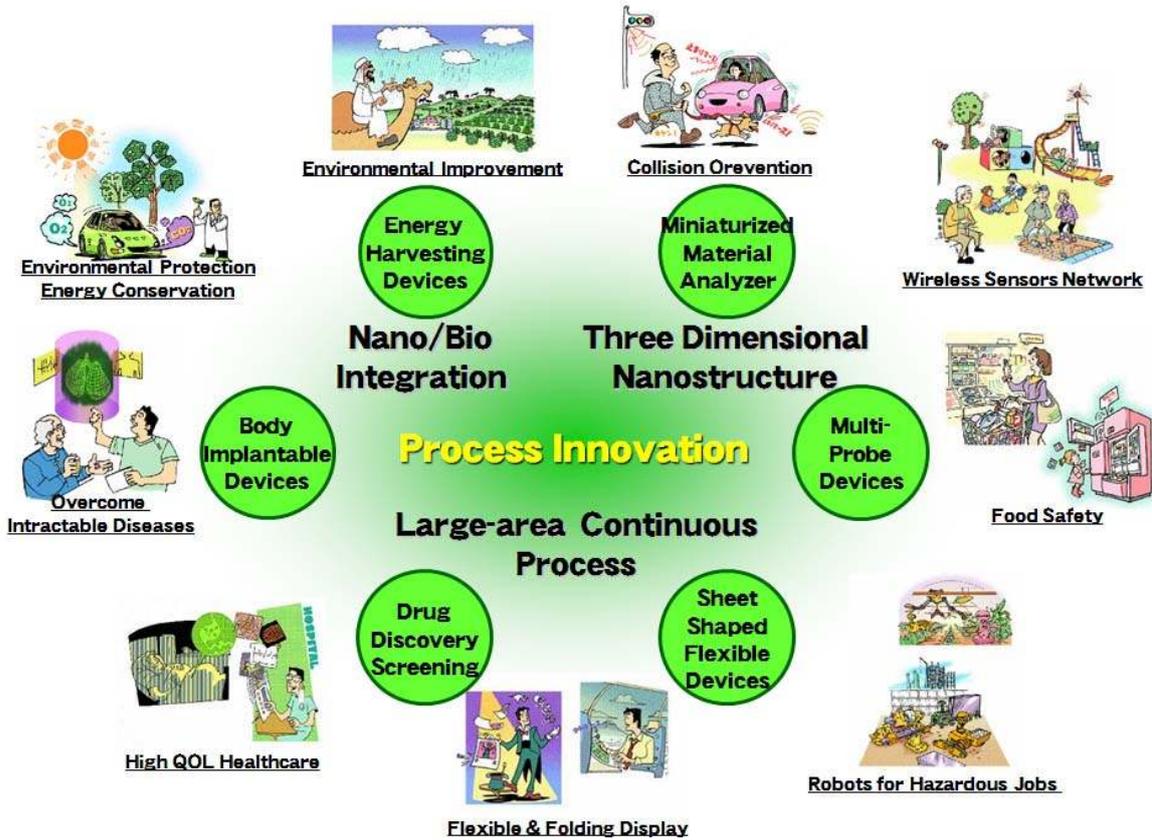


Fujita, Int. Sympo. Micromachine/Nanotech '07

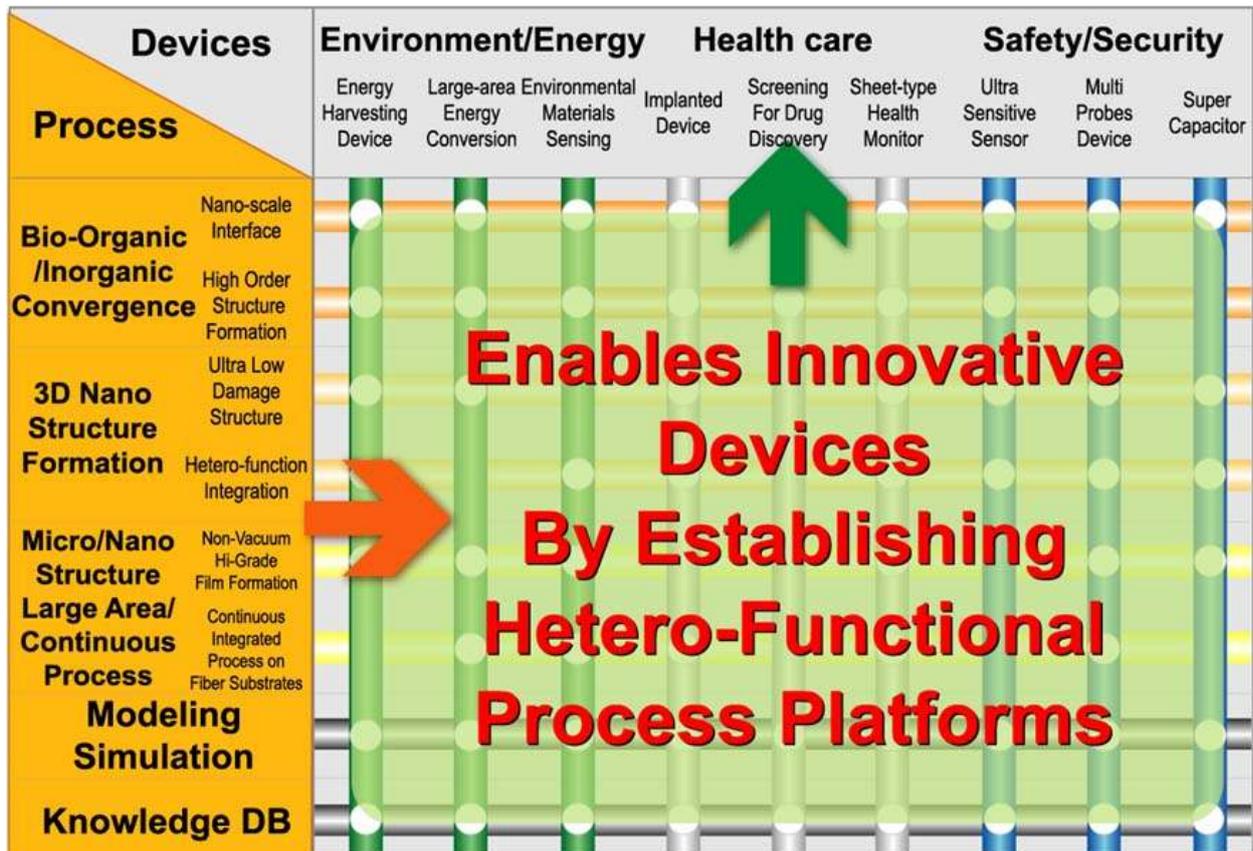
MEMS Technology & Market Development Roadmap



New Lifestyles being Enabled by BEANS[®]



Target of BEANS Project



Categories & Subjects of BEANS

① Bio/Organic Materials Integration Process

- ◆ Nano-scale Interfaces Treatment
- ◆ Bio/Organic Integrated Higher-Order Structure Formation

② Novel fabrication technology for 3-D Nano-structures

- ◆ Top-down fabrication of monolayer-flat, defect-free 3D structure
- ◆ Bottom-up technology for heterogeneous integration of materials and functions on 3-D platform
- ◆ 3-D nano-fabrication for aerospace applications

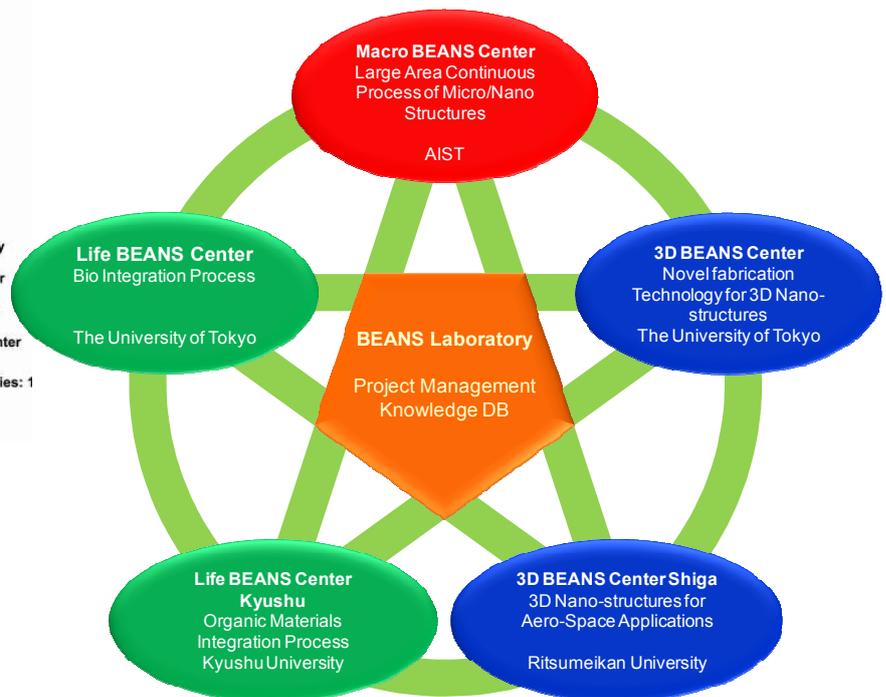
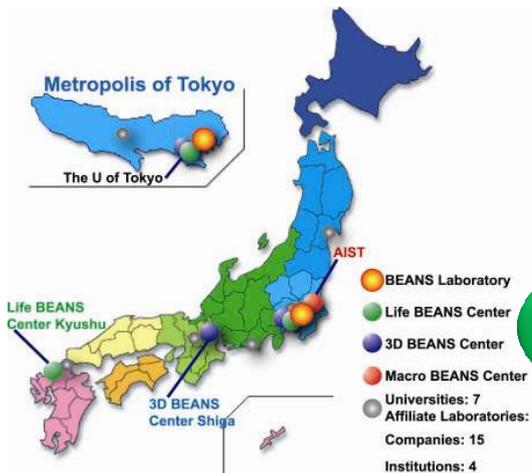
③ Large Area Continuous Process of Micro/Nano Structure

- ◆ Non-vacuum large-area deposition techniques of high-quality nano/micro materials
- ◆ Continuous nano/micro -machining and integration Process for fiber substrates

④ Building up of Knowledge Database

in Heterogeneous Technology Convergence Process Development

BEANS Research Initiative



Project Leader: Atsushi YUSA

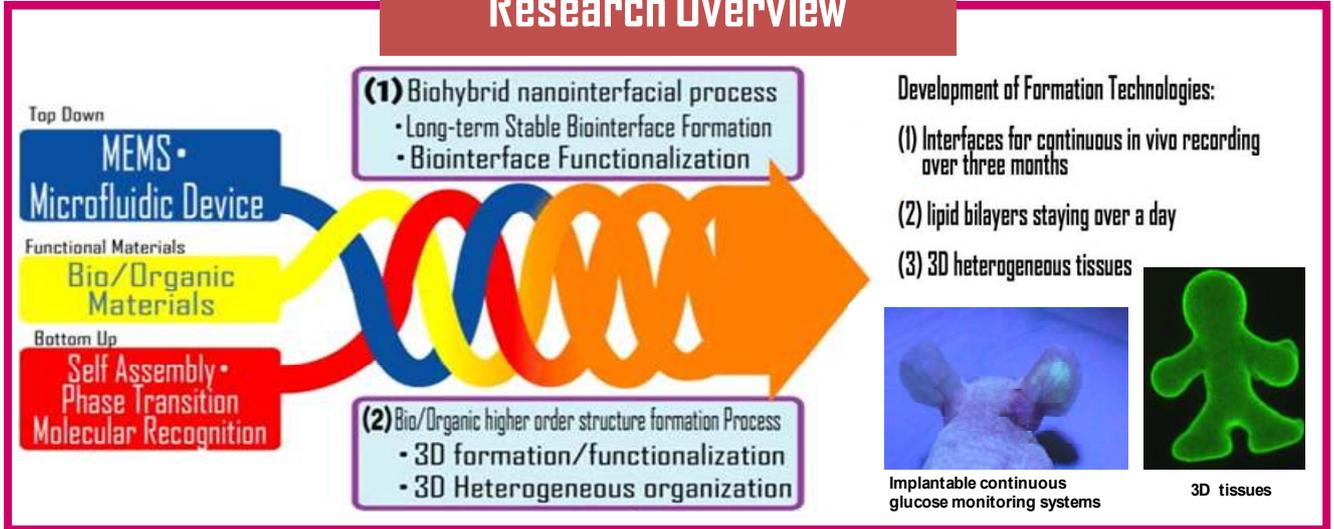
① -A Bio Materials Integration Process : Life BEANS Center

S.Takeuchi, Univ. of Tokyo

Market,
Social Needs
Technology Requirements

Health, Medicine ⇒ Implantable Device,
Highly Sensitive Chemical Sensors
Environment ⇒ Energy Harvesting Device
Harnessing Bio and Organic materials for MEMS

Research Overview



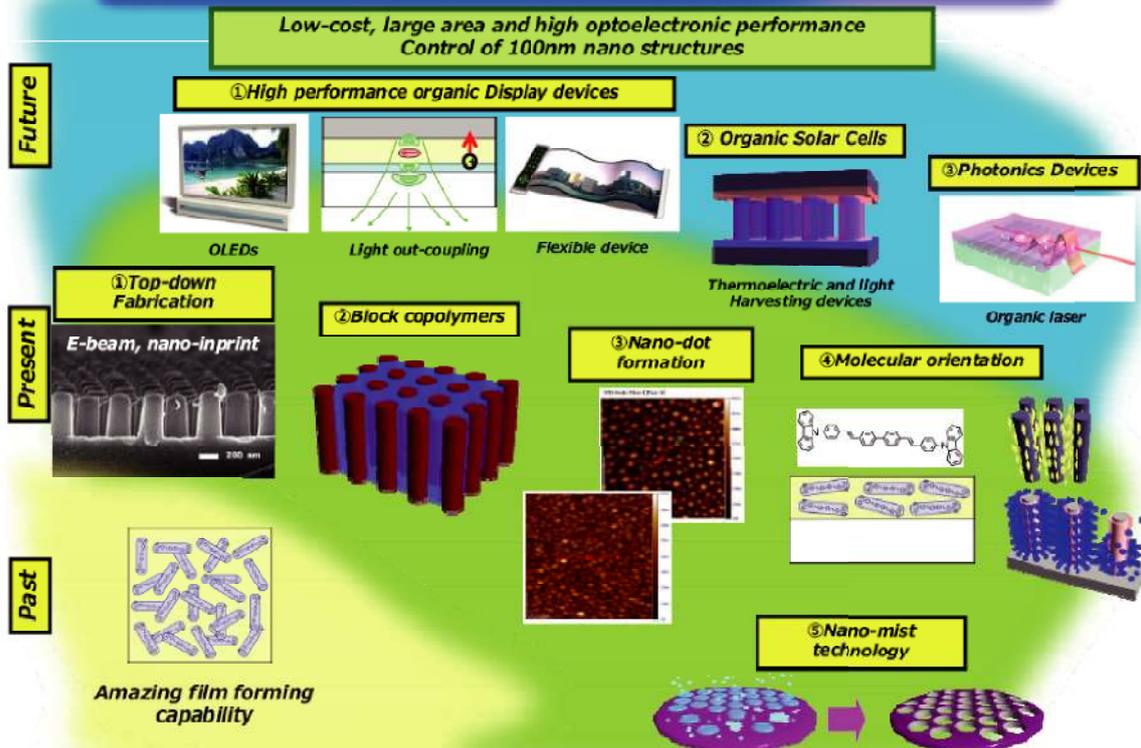
Impacts
Applications

- Implantable glucose sensors
- Single molecular Level, Ultra highly sensitive chemical sensors
- Sensors for drug kinetics with minimal load of animal experiments

① -B Organic Materials Integration Process : Life BEANS Center Kyushu Nano-Process Technology Enables Innovative Organic Devices

C.Adachi, Kyushu Univ.

Process development for Organic Nano-structures



② Novel fabrication technology for 3-D nano-structures : 3D BEANS Center

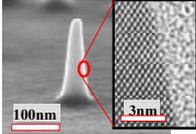
M. Sugiyama, Univ. of Tokyo

Needs

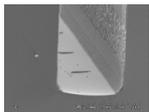
Sensor network for safe, secured and healthy life
High-sensitivity sensing, energy harvesting, high-density recording

Seeds

A monolayer-flat, defect-free 3D structure (Si, SiO₂ etc...)



Surface functionalization by foreign materials and nano-structures



Alignment of nanoparticles on trenches



Supercritical-fluid conformal deposition

Multi-scale&uniform nano-fabrication

Nanopores

μm topology

Applications

Super-capacitors, Ultra-high-sensitivity sensors, Tbit/cm² recording, nm-resolution high-throughput lithography, Multiband-spectroscopy from space

Simulation, nano-tribology

Research items

(1) Top-down fabrication of monolayer-flat, defect-free 3D structure

- Neutral beam etching
- Nano-domain modification by fs-laser

(2) Bottom-up technology for heterogeneous integration of materials and functions on 3-D platform

- Supercritical-fluid deposition and coating
- Assembly of nanoparticles, nanodots and nanotubes on 3-D platforms

(3) 3-D nano-fabrication for aerospace applications

- Nano-structure imprint on a 3-D microstructure
- Filters for multi-band selection

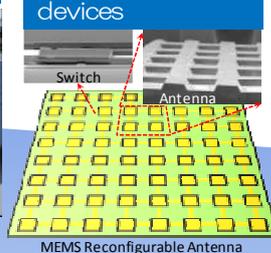
③ Large Area Continuous Process of Micro/Nano Structure : Macro BEANS Center

T. Itoh, AIST

Large-area energy harvesting devices



Large-area communication devices



Large-area display devices

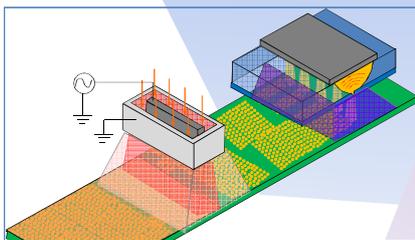


Sheet-type health-care (monitoring) devices

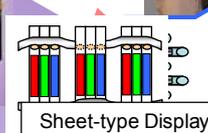


Meter-size devices

To develop new fabrication process which deposits high quality nano/micro materials on meter-size substrate without vacuum process equipment

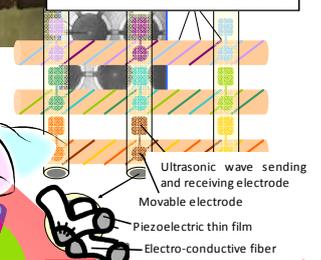


Non-vacuum large-area deposition techniques of high quality nano/micro materials



Sheet-type Display

Ultrasonic Probe Sheet



Flexible sheet-type devices

Wearable energy harvesting devices

To develop new fabrication process that realizes flexible sheet-type large-area devices utilizing micromachining and weaving integration of fiber substrates instead of micromachining of large substrates



Continuous nano/micro-machining and integration process for fiber substrates

Smart jackets for safety and security



Flexible touch sensor

Outcome of 2008

Item	Headquarter	Life BEANS Center	Life BEANS Center Kyushu	3D BEANS Center	3D BEANS Center Shiga	Macro BEANS Center	Total
Patents	0	1+(3)	4+(2)	(1)	2	3+(2)	10+(8)
Press Release	3	2	0	0	3	0	8
Publications Conference	7	11	2	3+(7)	0	4	27+(7)
Publications Journal	0	(1)	2	0	0	0	2+(1)

() under Applications

BEANS Laboratory

Establish March 24, 2009

Mission

- Executing BEANS Project (Hetero-functional Integrated device Technology Development Project)
- Sending researchers who are assigned from the member companies of BEANS Laboratory to BEANS Centers, and collaborating with researchers of universities and National Institutes

Chairperson Hisao SAKUTA

Executive Director Keiichi AOYAGI

Director Atsushi YUSA (Project Leader)

Members 20 Organizations (Companies and Institutions) as of July, 2009

DENSO Corp.	FUJI Electric Systems Co., Ltd.	FUJUKURA Ltd.
FURUKAWA Electric Co., Ltd.	LINTEC Corp.	Mathematical Systems, Inc.
MITSUBISHI Chemical Medience Corp.		MITSUBISHI Electric Corp.
MIZUHO Information & Research Institute, Inc.		OLYMPUS Corp.
OMRON Corp.	PANASONIC Electric Works, Ltd.	SEIKO Instruments Inc.
TERUMO Corp.	TOSHIBA Corp.	TOSHIBA Machine Corp.
Institute for Unmanned Space Experiment Free Flyer		
Institute of System, Information Technologies and Nanotechnologies		
Japan Resources Observation System & Space Utilization Organization		
Micromachine Center		

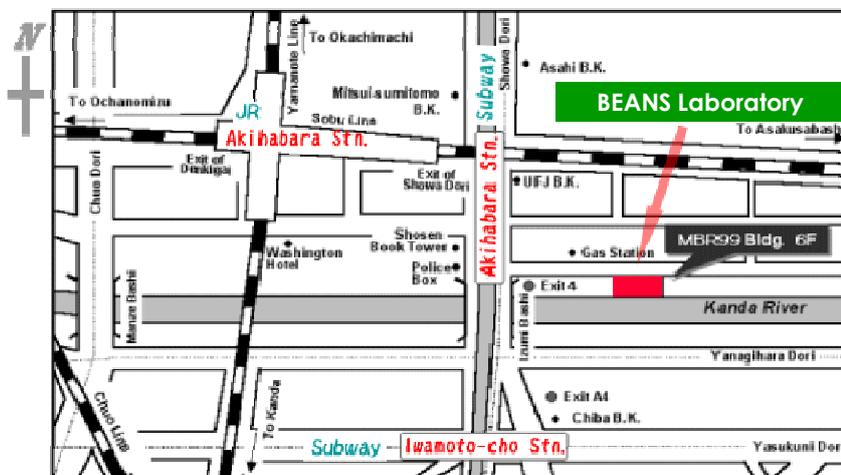
Number of researchers 81 (Including affiliates)

BEANS Center Life BEANS Center, 3D BEANS Center: Institute of Industrial Science, The University of Tokyo

Life BEANS Center Kyushu: Center for Future Chemistry, Kyushu University

3D BEANS Center Shiga: Ritsumeikan University

Macro BEANS Center: Advanced Industrial Science and Technology



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