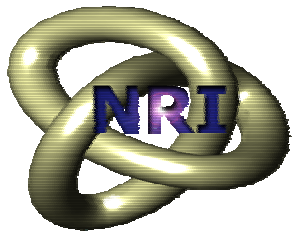
Strategic Nanotechnology Global Networking: Current Status and Proposal of AIST

Hiroshi Yokoyama

Nanotechnology Research Institute
National Institute of
Advanced Industrial Science and Technology(AIST)



What is crucial:

Productive Alliance for Leveraging Individual R&D Efforts

and

Making Possible Continual Stream of Innovations from Basic Research to Market Place

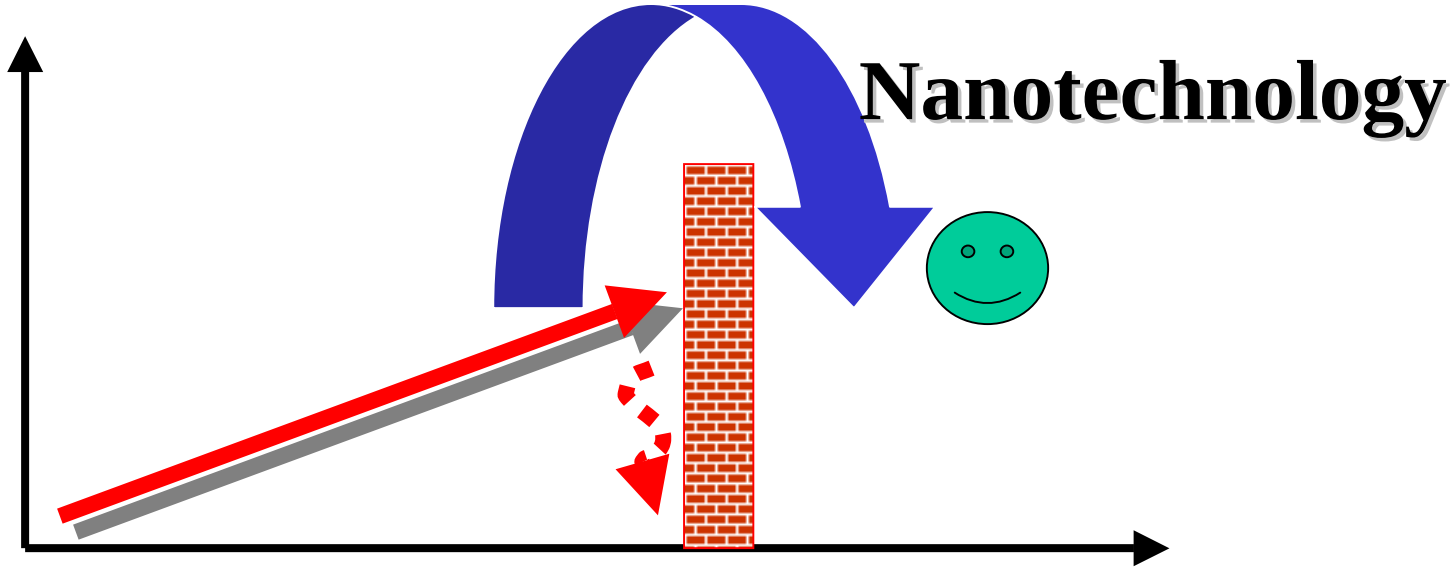
Ex. Adaptive / On-demand Production System

enabling Less Costly & More Environmental Friendly Manufacturing

AIST

Quantum Leap of Industrial Technology

Destructive Technology! For Existing Industries



AIST

TOYOTA's latest hybrid car on the market:

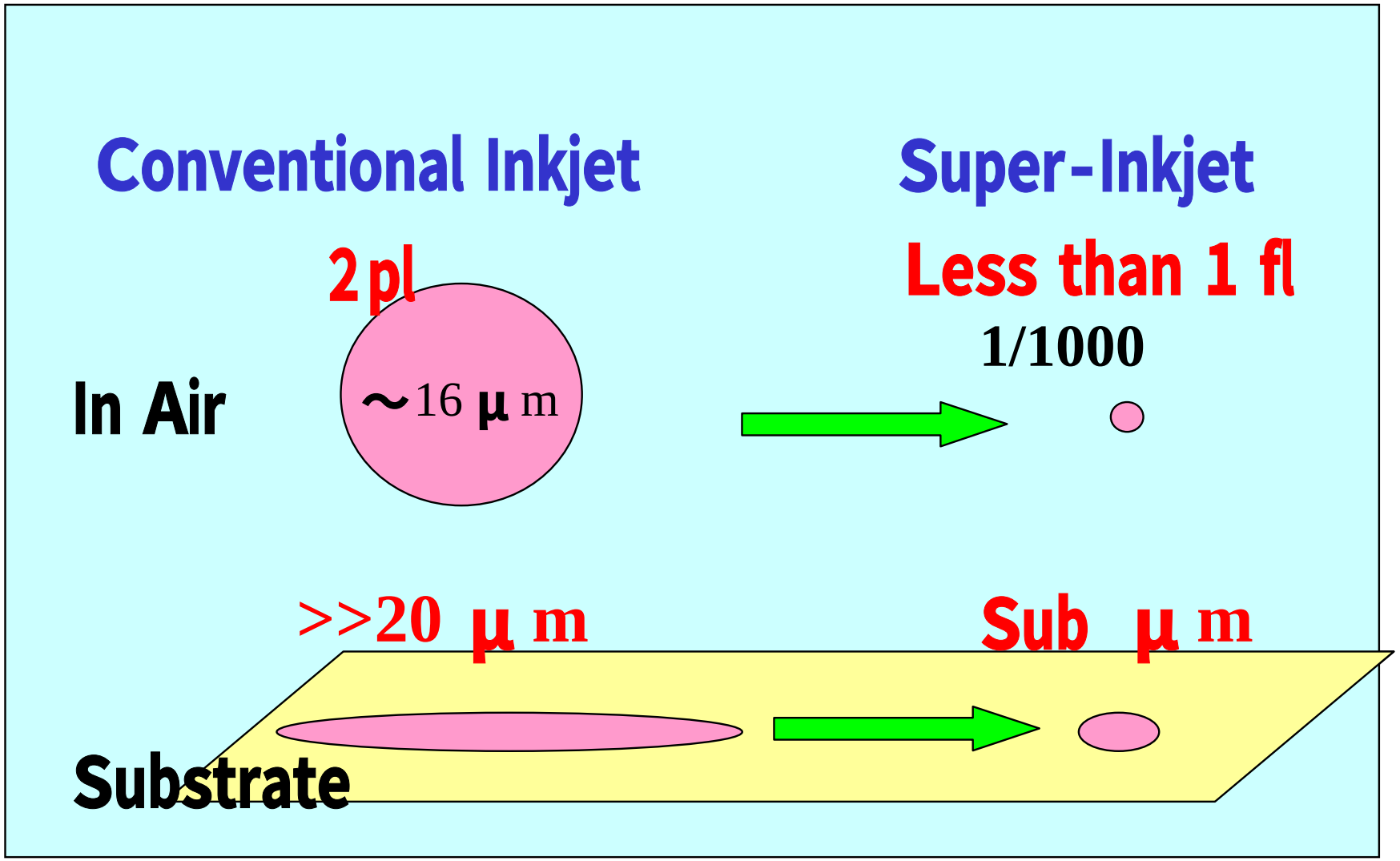
35 km/l !

What if we could make it 100km/l or larger by nanotechnology?

Consumers are becoming more and more environment and cost conscious.

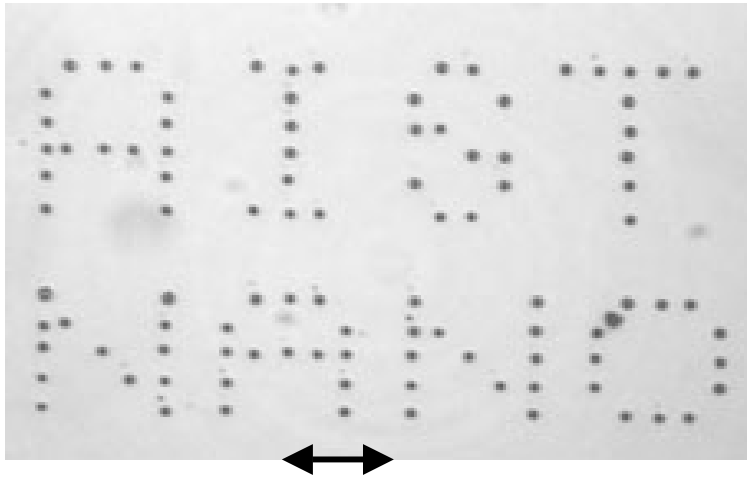
So are we!

AIST

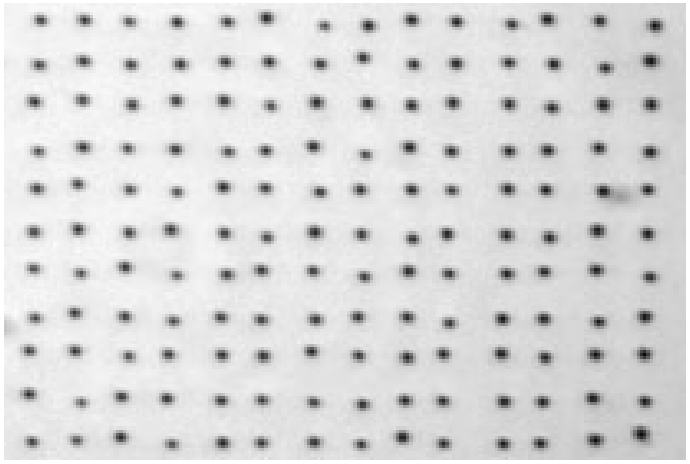

Conventional Inkjet
Super-Inkjet
2 pl
Less than 1 fl
1/1000
In Air
~16 μm
>>20 μm
Sub μm
Substrate

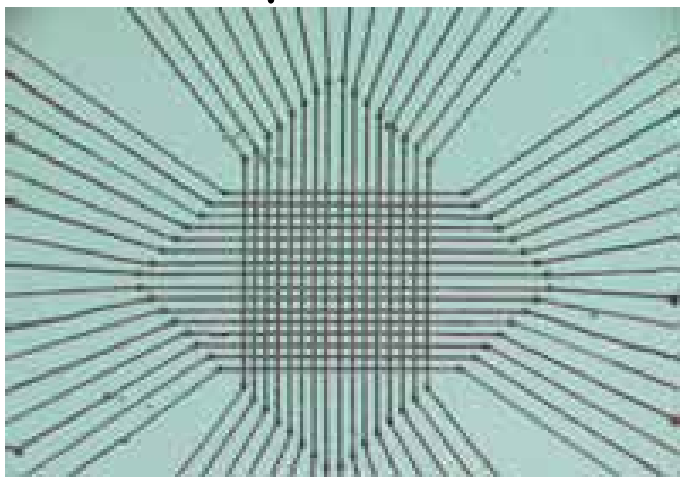
AIST

Super Inkjet Technology: Trend in On-Demand Manufacturing



10μm

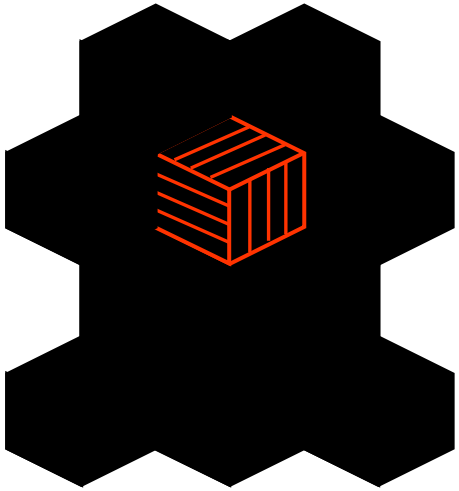


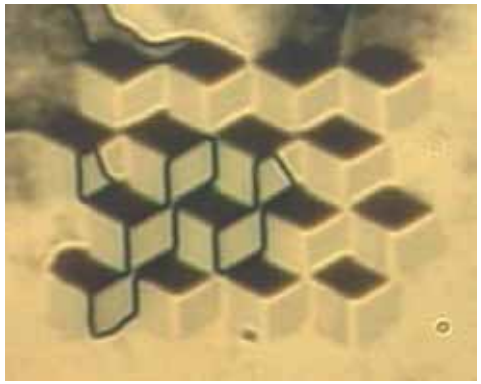


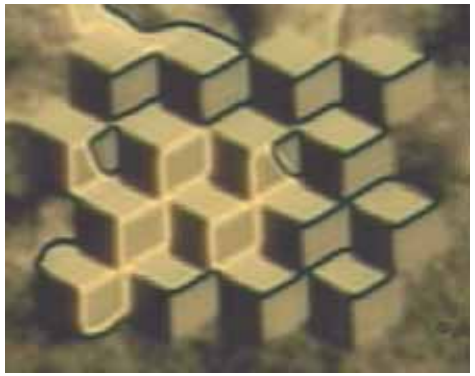
AIST

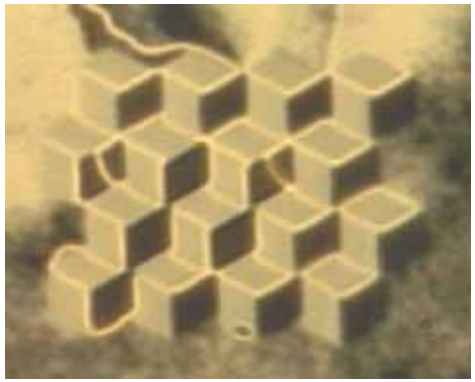
Multi-stable Liquid Crystal Device:

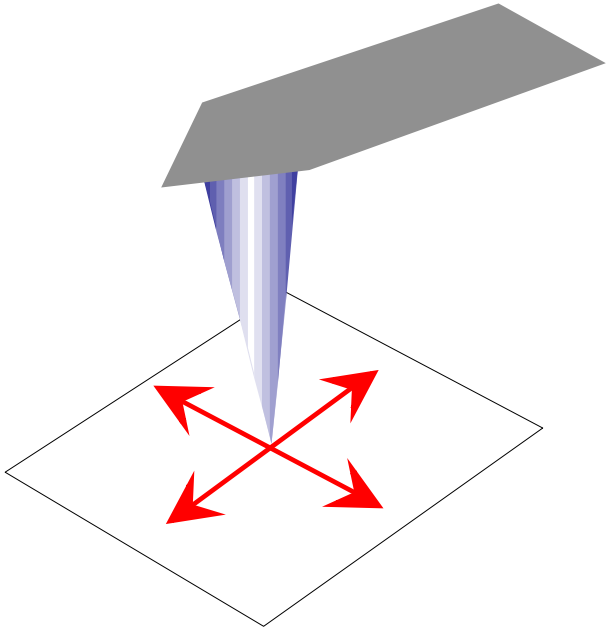
AFM-Fabricated Microscopic Surface Pattern











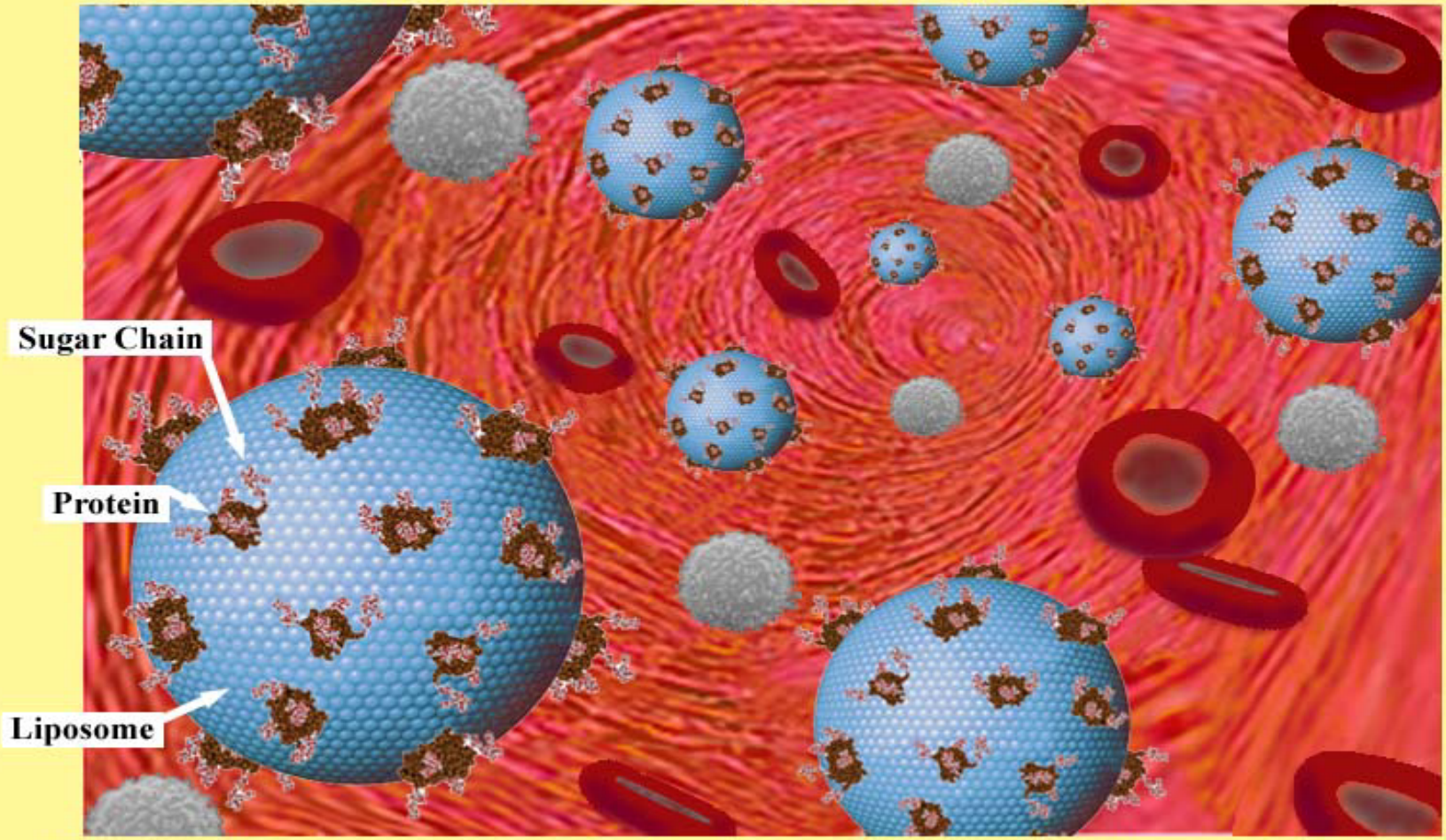
Appl. Phys. Lett. 78 (3035) 2001.

20μm

Nature, November 14, 2002.

AIST

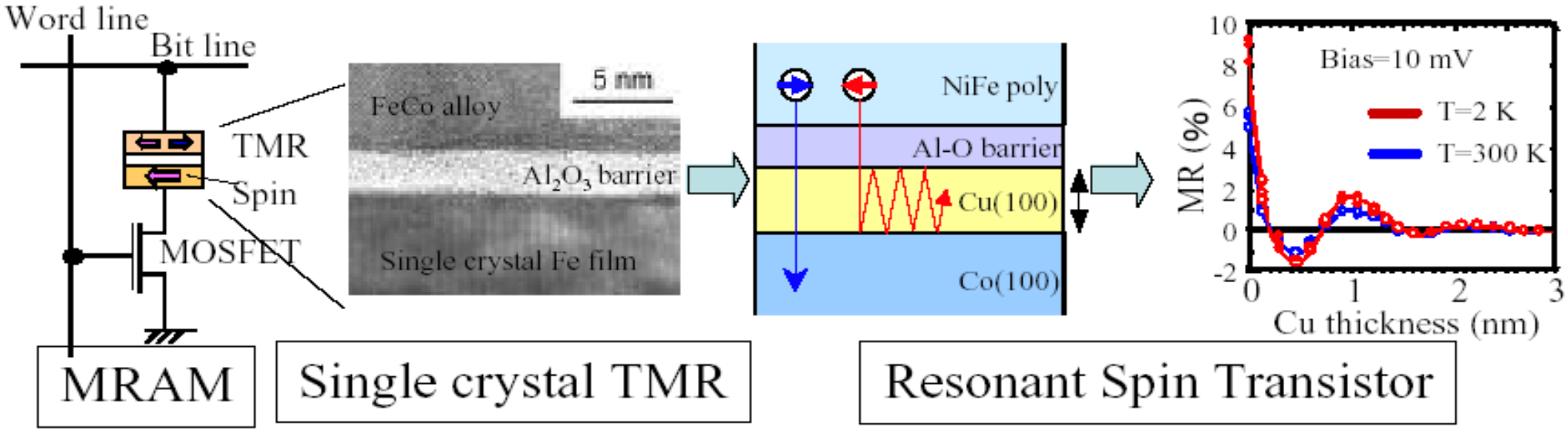
Molecular Assembly and Functional Control Based on Nanoparticle Systems



This figure illustrates a novel type of synthetic liposomal nanoparticle (100 nm in diameter) which bears sugar chain-protein conjugates and functions as DDS (Drug Delivery System) in a blood vessel.

AIST

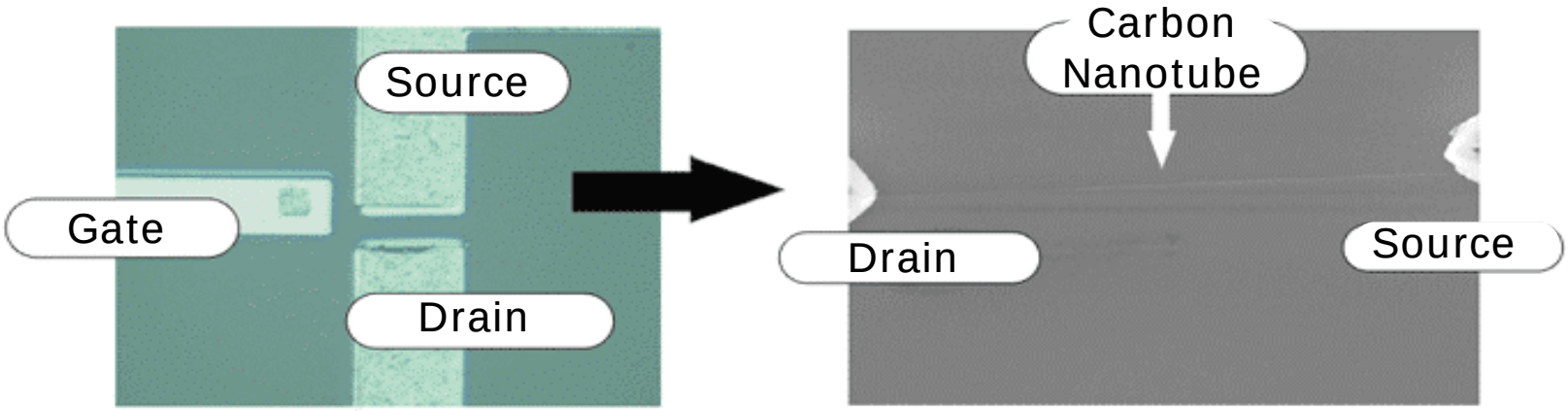
Spintronic Device: Single-crystal-junction TMR for Gbit MRAM



TMR: Tunneling Magnetic Resistance, MRAM: Magnetic RAM

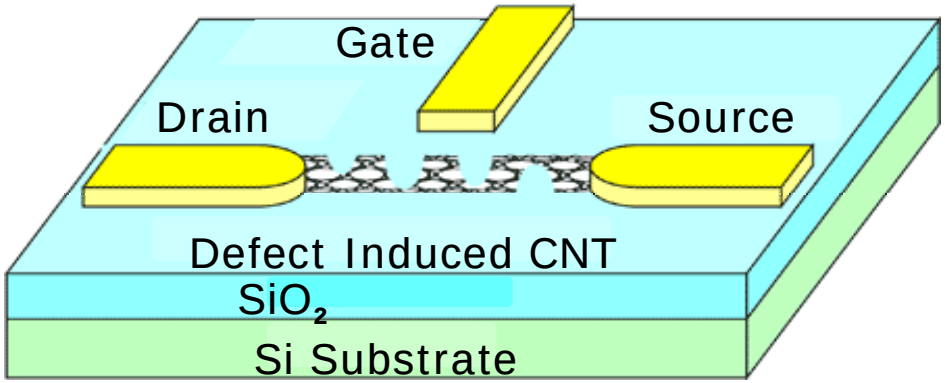
AIST

Carbon Nanotube Quantum Effect Transistor

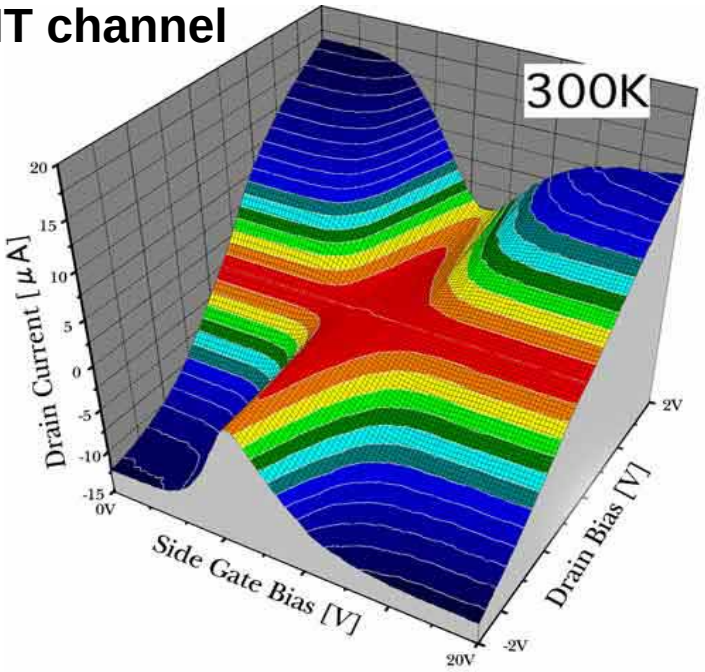


(a) Single electron transistor (SET)

(b) CNT channel



(c) Schematic view of SET with defect induced CNT channel



(d) I-V characteristics of SET

Collaboration with Fujitsu

AIST

Business: *Layer 5*

Development: *Layer 4*

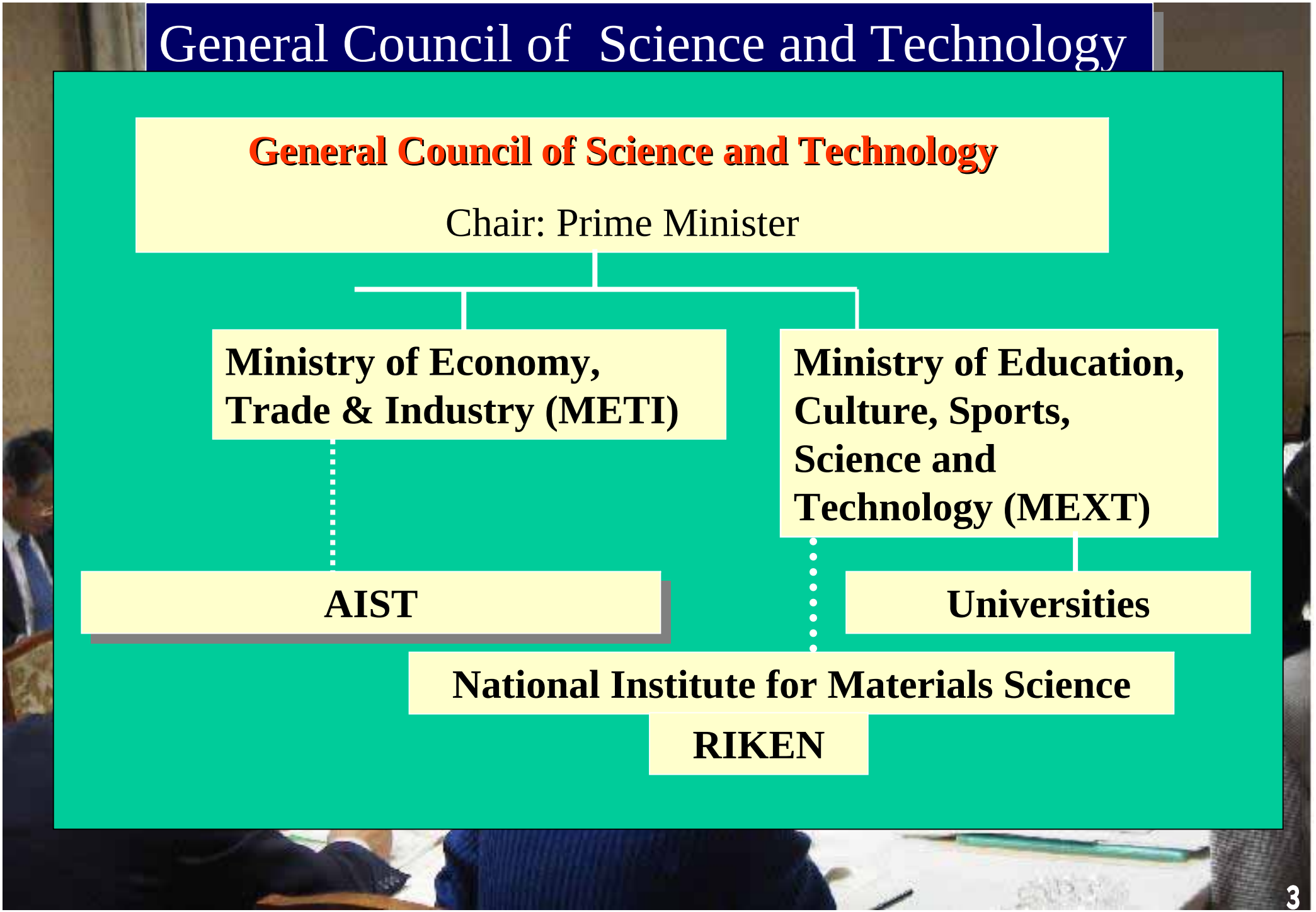
Basic Research: *Layer 3*

Infrastructure / Facility: *Layer 2*

Strategy & Policy: *Layer 1*

AIST

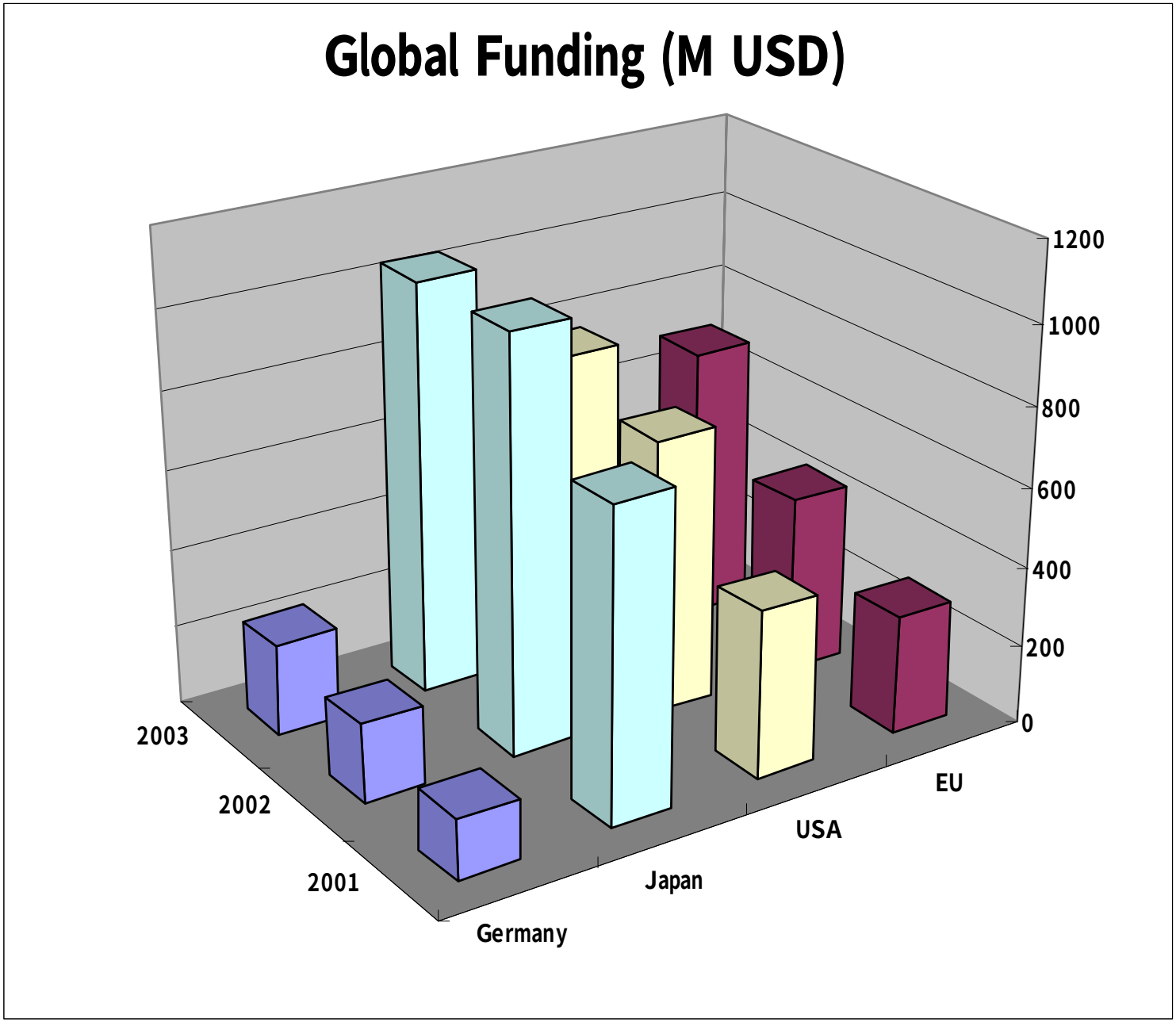
General Council of Science and Technology



Japanese Government is ever more strongly committed to Science & Technology to revive her economy, making pledge to invest

250 Billion US$

over 5 years.



Courtesy Lerwen Liu, NanoGlobe Ltd.

AIST

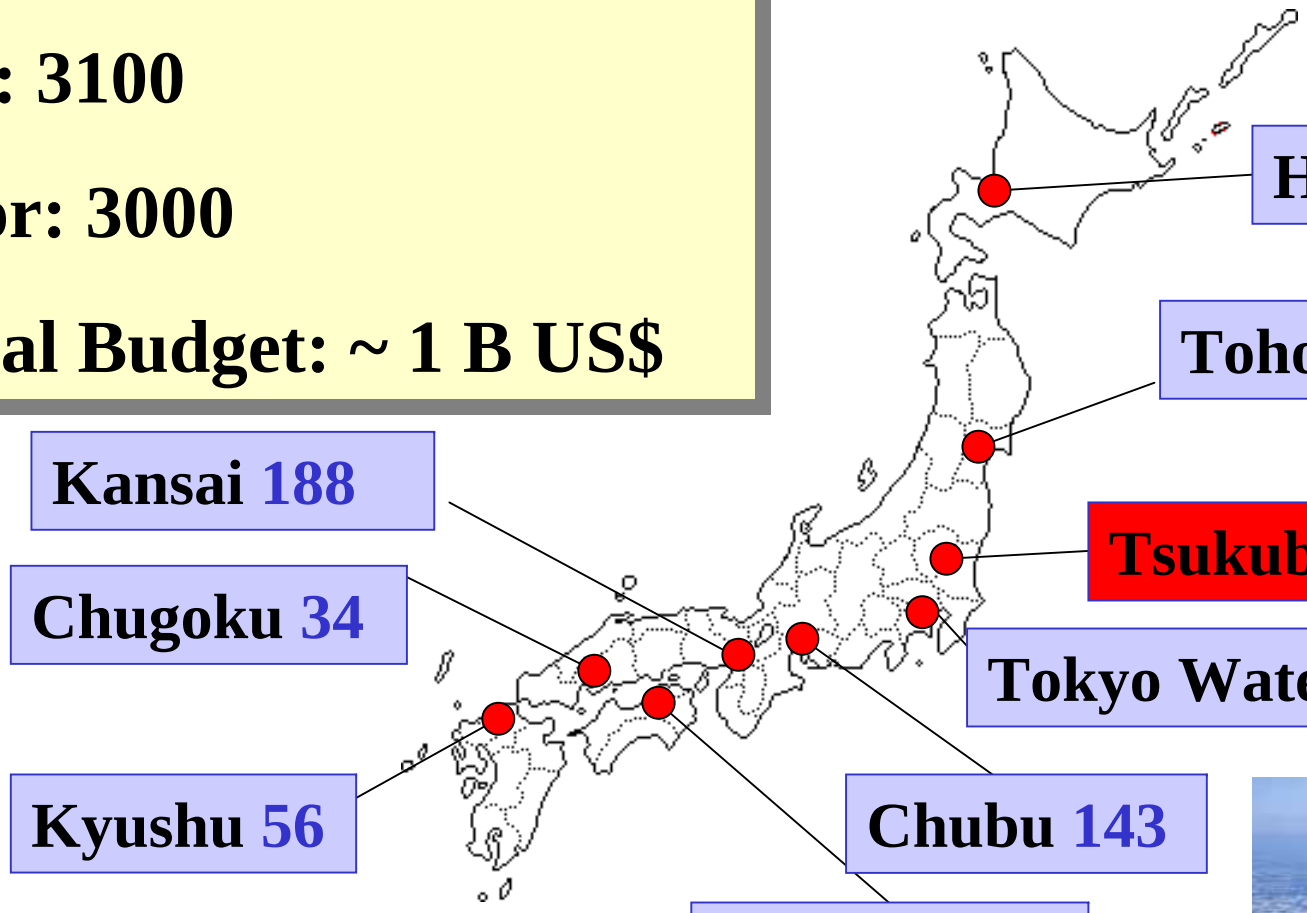
Research Bases of AIST around Japan

Researcher: 2400

Total: 3100

Visitor: 3000

Annual Budget: ~ 1 B US$



Hokkaido 68

Tohoku 35

Kansai 188

Tsukuba 1,832

Chugoku 34

Tokyo Waterfront 39

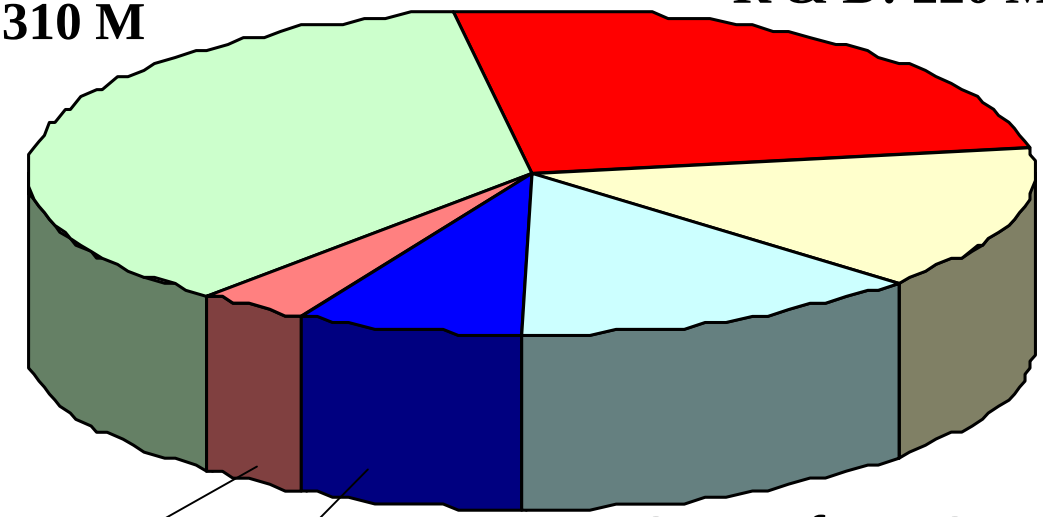
Kyushu 56

Chubu 143

Shikoku 31

FY2002 AIST Revenue
(total budget: ~1B US$)

+ Extra: 700 M



Payroll: 310 M

R & D: 220 M

Utility Expense & Others: 110 M

Grants from Government: 110 M

Other Income: 30 M

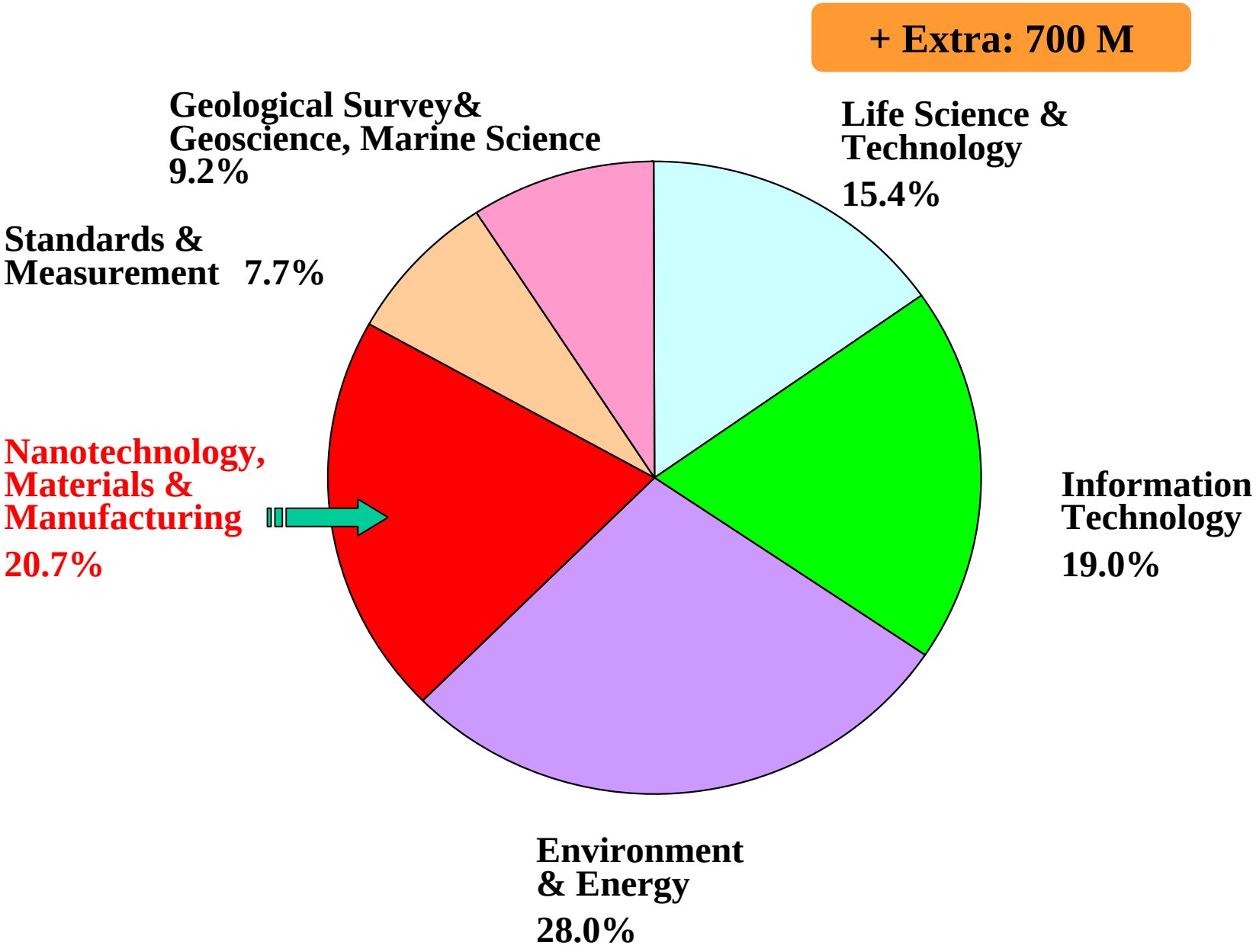
Contract Research & Research Grants: 180 M

Funds from Sectors other than Government: 70 M

AIST

FY2002 Distribution of R&D Investment
(total budget: ~1B US$)

+ Extra: 700 M



AIST

Business: *Layer 5*

Development: *Layer 4*

Basic Research: *Layer 3*

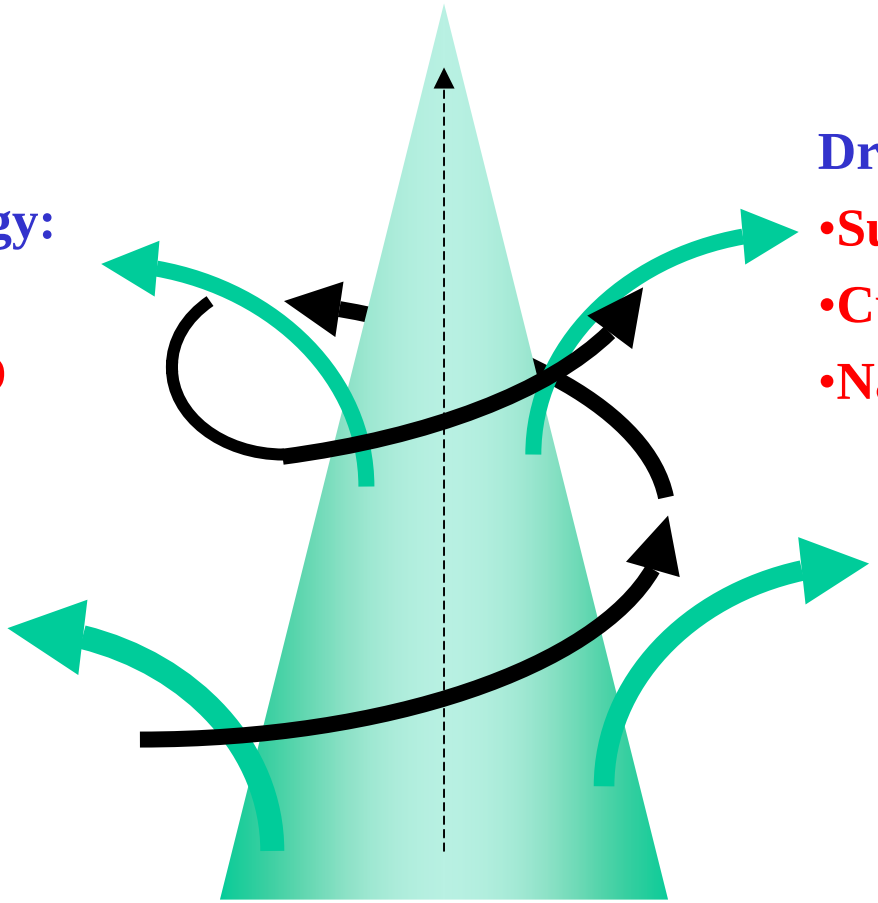
Infrastructure / Facility: *Layer 2*

Strategy & Policy: *Layer 1*

AIST

Sequential Deployment of Nanotech Outputs for Sustainable R&D

- Molecular Device/ Quantum Computer
- Artificial Photo-Synthesis
- Computational Materials Design



Display Technology:
- CNT FED
- Multi-Stabe LCD

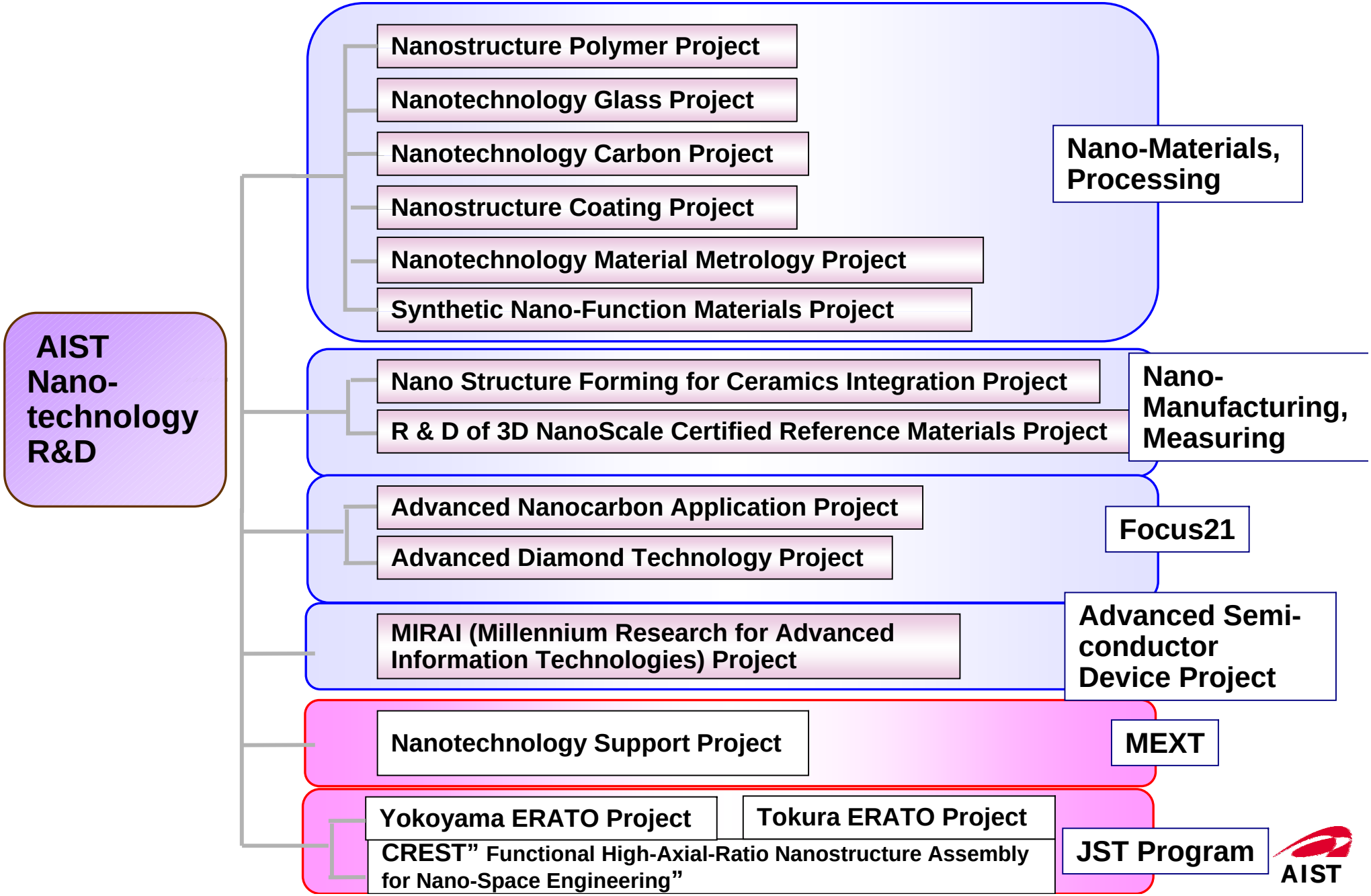
Drug Delivery System:
- Sugar/Protein DDS
- Cubic LC Absorbent
- Nano-particle (DNA Tag)

Characterization Tool:
- CNT Probe

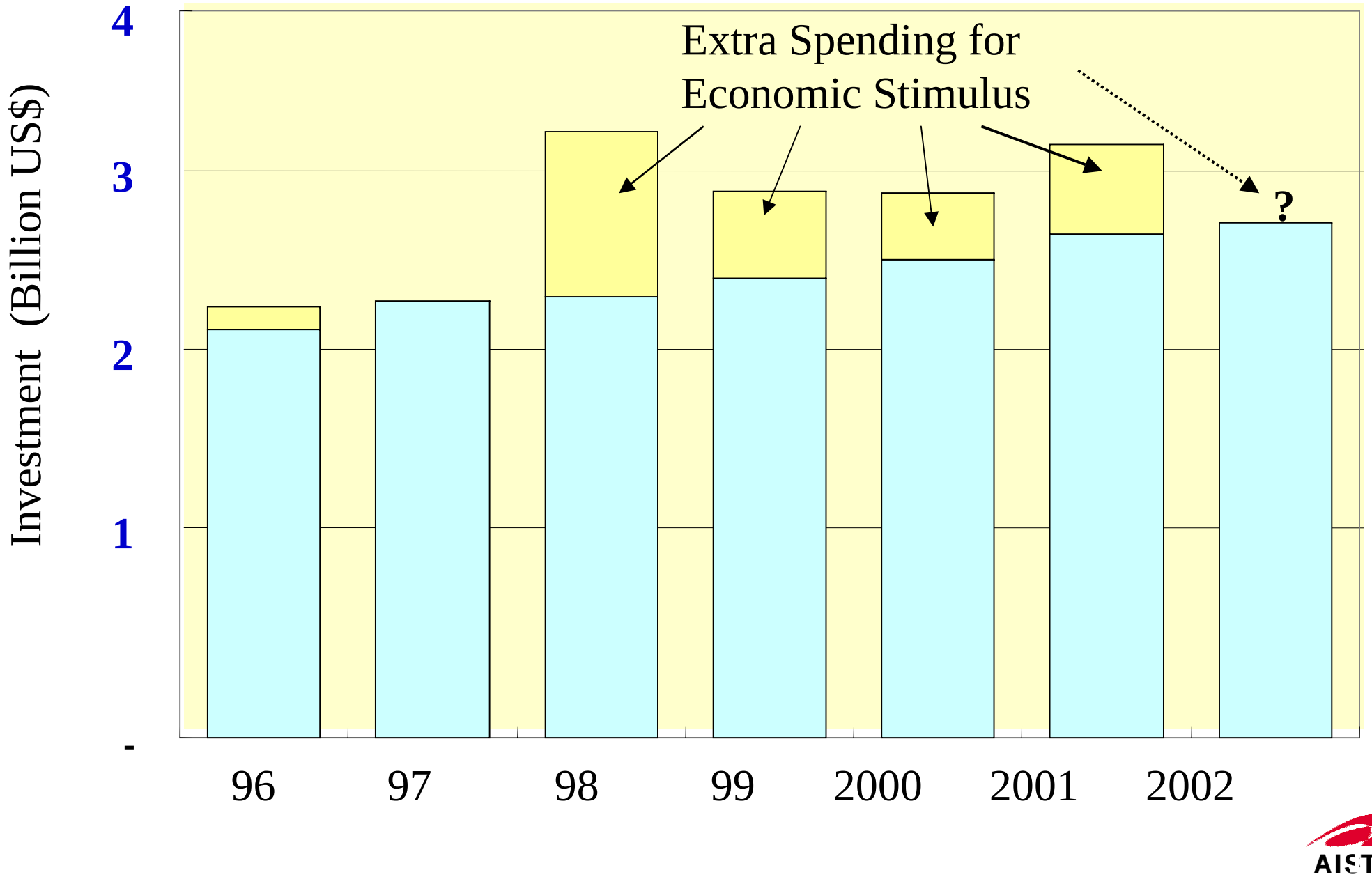
Manufacturing:
- Super-Inkjet
- Probe fabrication

AIST

Current Nanotechnology Programs in AIST



Government R & D Investment



AIST

Business: *Layer 5*

Development: *Layer 4*

Basic Research: *Layer 3*

Infrastructure / Facility: *Layer 2*

Strategy & Policy: *Layer 1*

AIST

MEXT

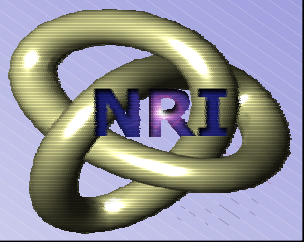
Nanotechnology Support Project

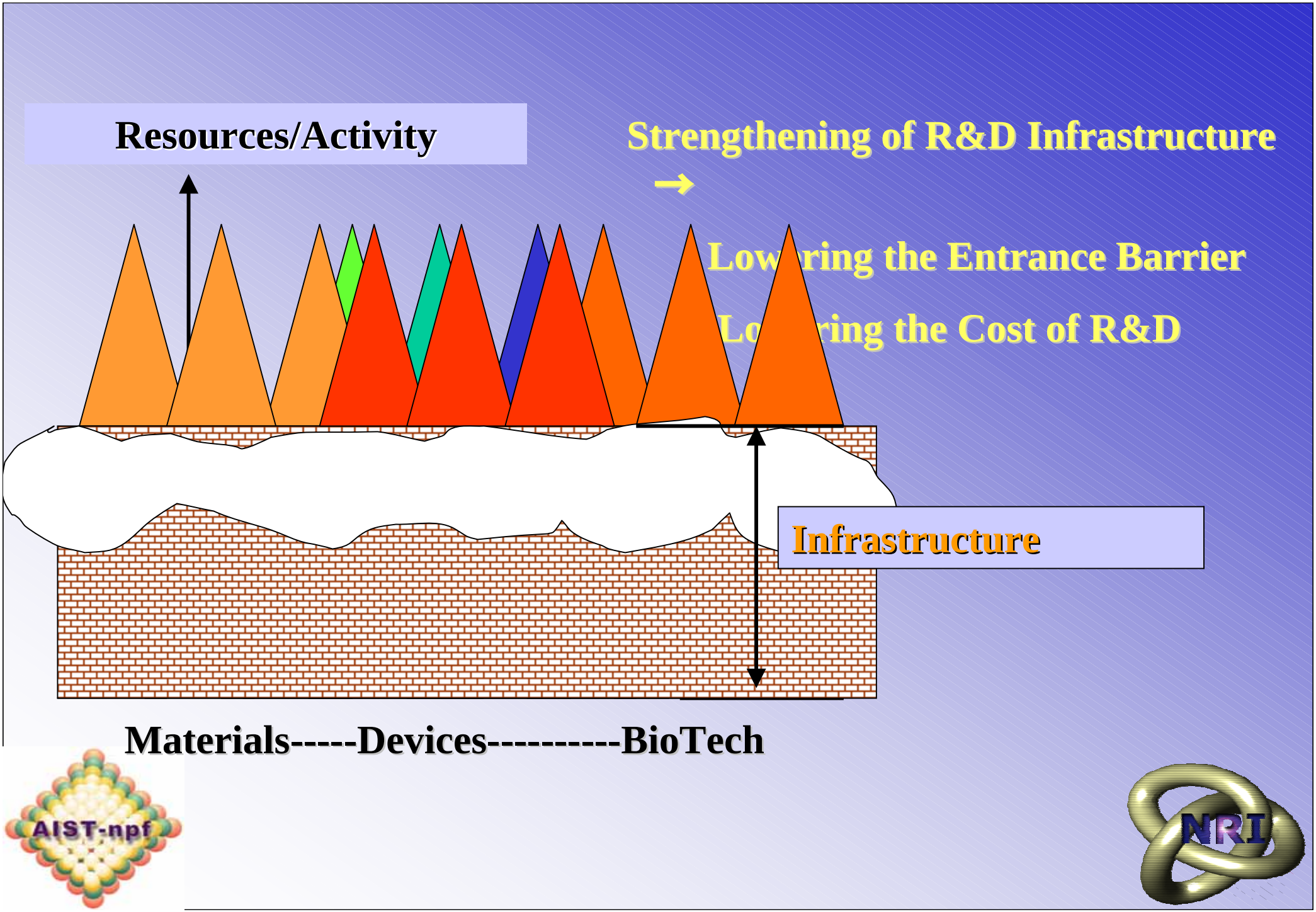
NanoFoundry Group

NanoProcessing Partnership Program (NPPP)

http://www.nanoworld.jp/nppp/index.htm

nppp_info@m.aist.go.jp




Resources/Activity
Strengthening of R&D Infrastructure
→
Lowering the Entrance Barrier
Lowering the Cost of R&D
Infrastructure
Materials-----Devices----------BioTech
AIST-npf
NRI

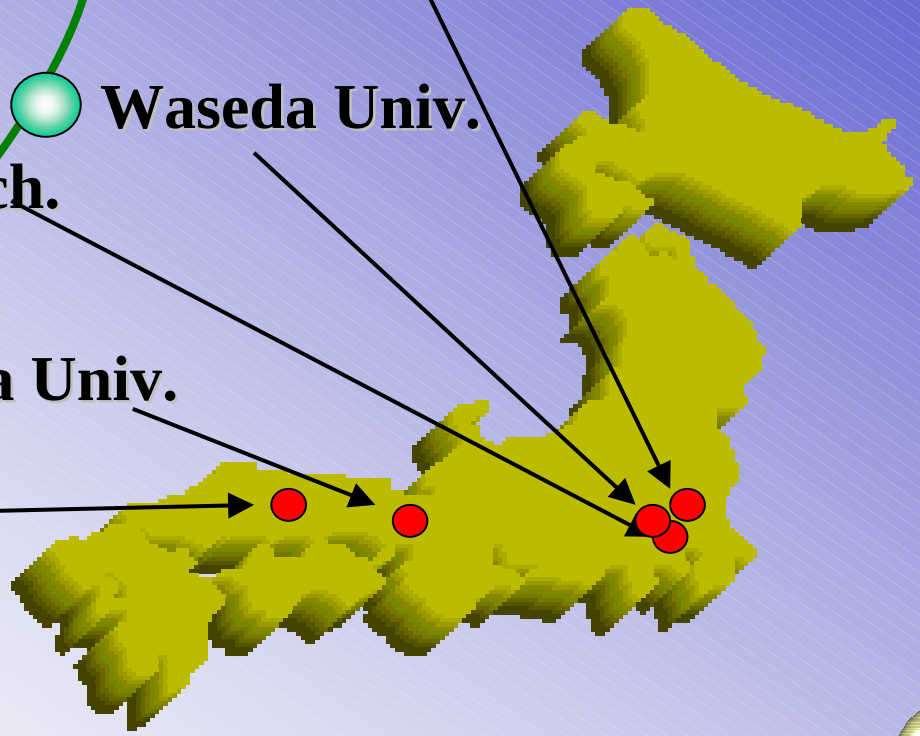
AIST NPF- NPPP

Waseda Univ.

Tokyo Inst. Tech.

Osaka Univ.

Hiroshima Univ.



AIST-npf

NRI

Business: *Layer 5*

Development: *Layer 4*

Basic Research: *Layer 3*

Infrastructure / Facility: *Layer 2*

Strategy & Policy: *Layer 1*

AIST

Nanotechnology Business Creation Initiative, consisting of 300 member companies, is now being established in Japan by METI's lead.

Its mission is to enhance competence of Japanese nanotech community in the highly competitive international arena.

AIST

Business: *Layer 5*

Development: *Layer 4*

Basic Research: *Layer 3*

Infrastructure / Facility: *Layer 2*

Strategy & Policy: *Layer 1*

AIST

Expectation on Network

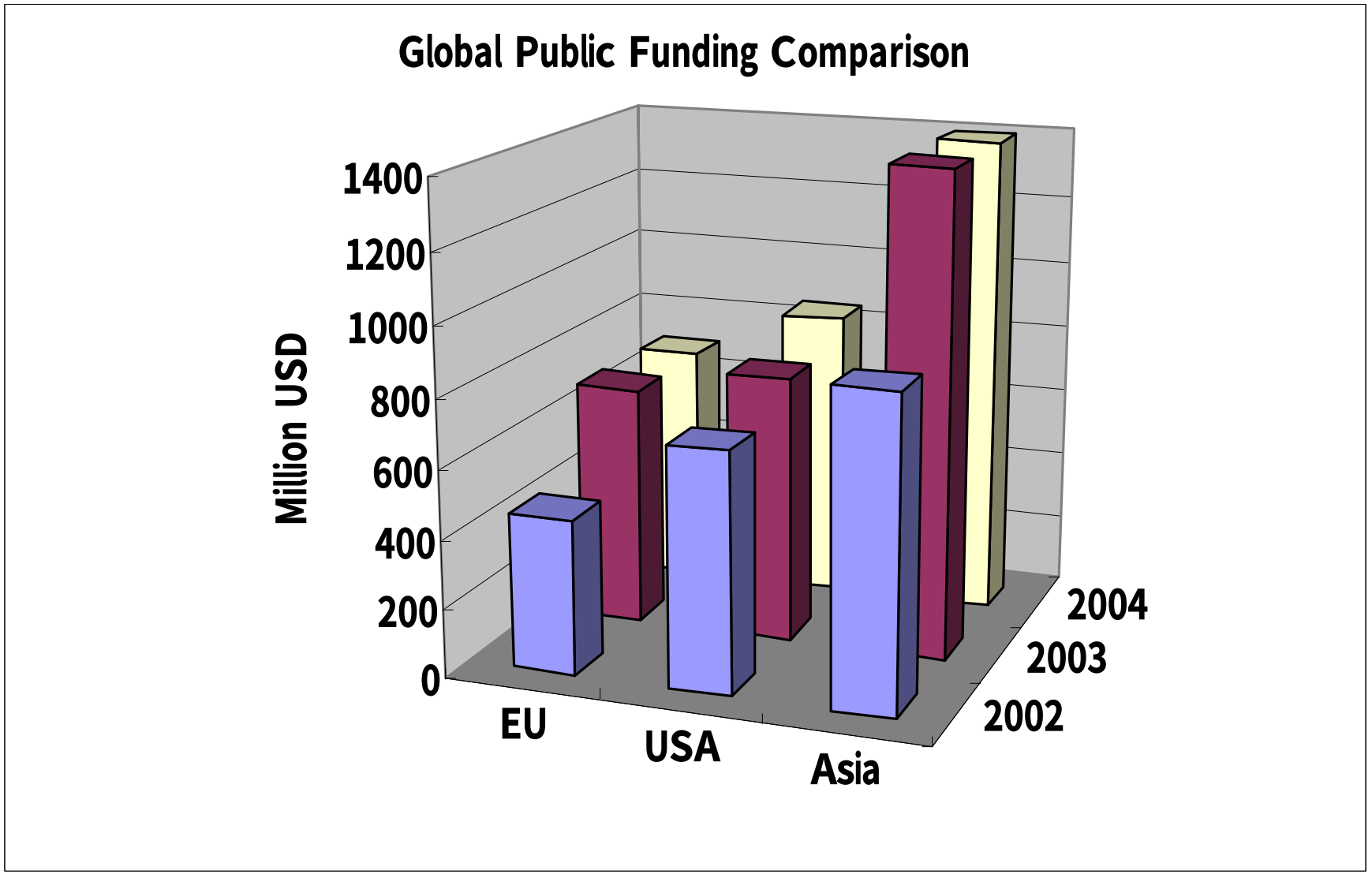
- **Complementary R&D**
- **Mutual Benefit (Technology, Information, Patent, Business…)**
- **Human Resource Development**
- **Standardization**

AIST

Toward Nanotechnology Global Network

- CNRS, France
- KISTI, Korea
- ITRI, Taiwan
- Cambridge University, UK (in progress)
- etc.

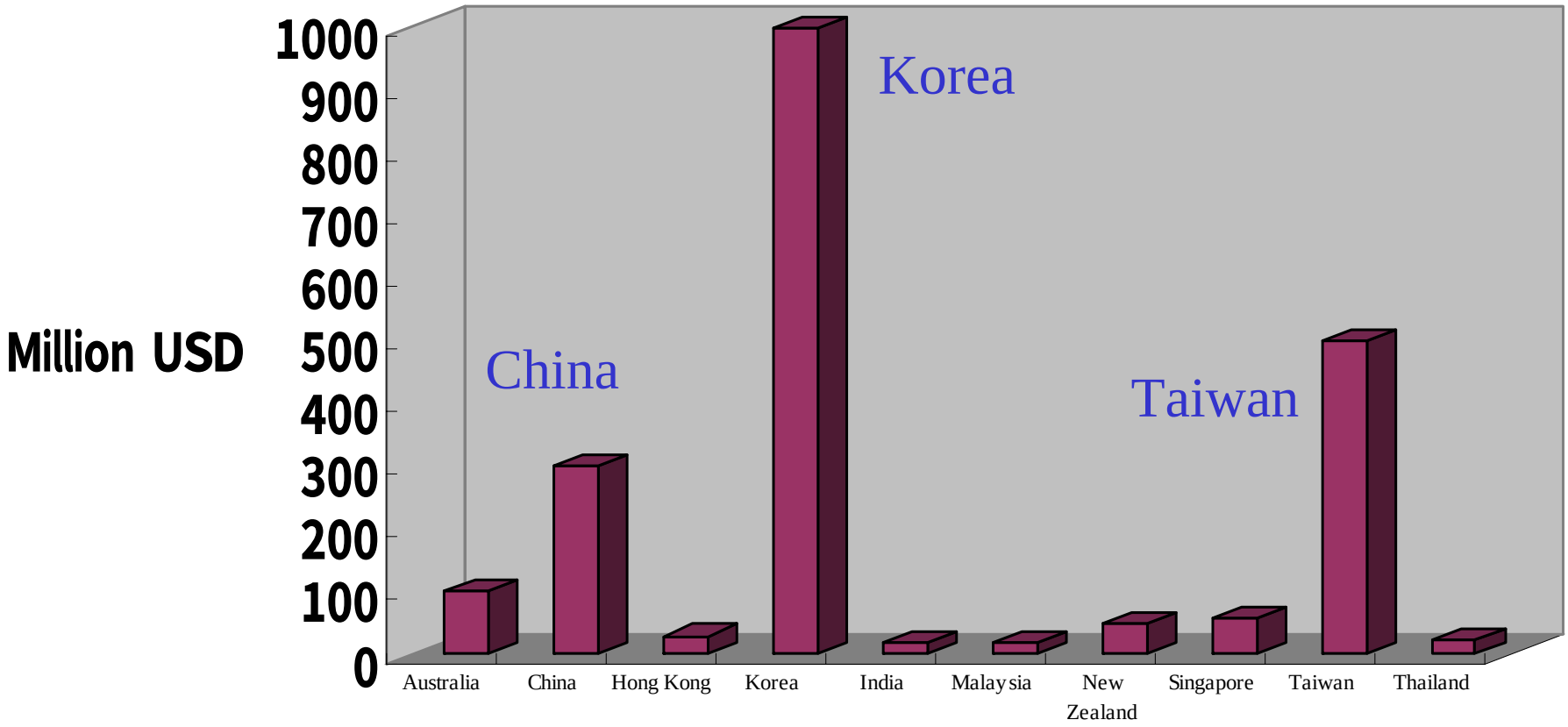
AIST



Courtesy Lerwen Liu, NanoGlobe Ltd.

AIST

Asian Funding during 2003-2007



Courtesy Lerwen Liu, NanoGlobe Ltd.

AIST

AIST

Toward the *Gateway* to Nanotech Asia

Across All Layers of Nanotechnology

- 2nd Asian Nanotech Forum Summit in Thailand, March 2004. Jointly Sponsored by Royal Thai Government and NEDO, METI & AIST

- Networking of Nanotech Support Facilities (MEXT)

- Nano2B AIST Symposium at Nanotech 2004 in March, 2004

- Call for Further Joint Research Programs

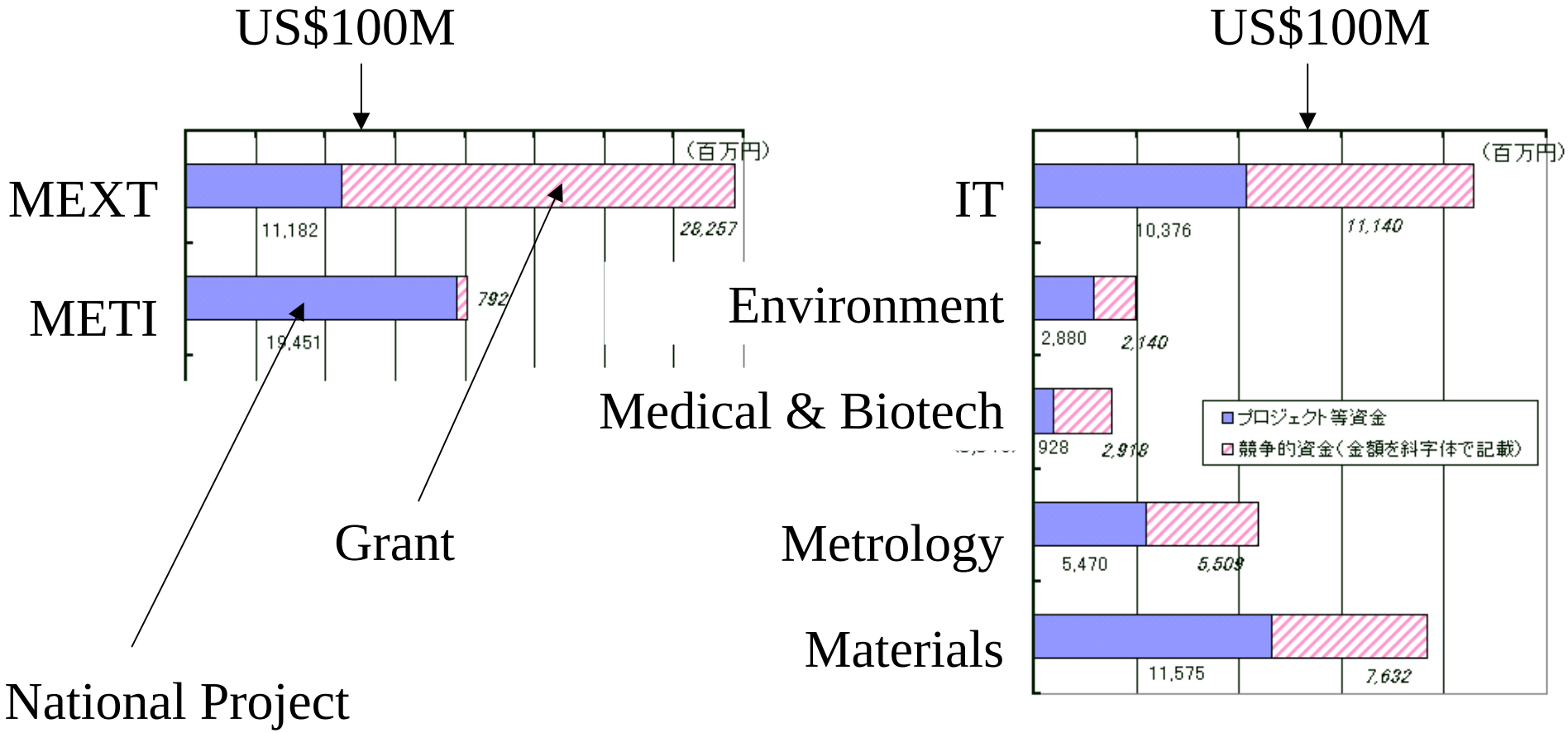
And More…

Let’s enjoy nanotechnology!

AIST

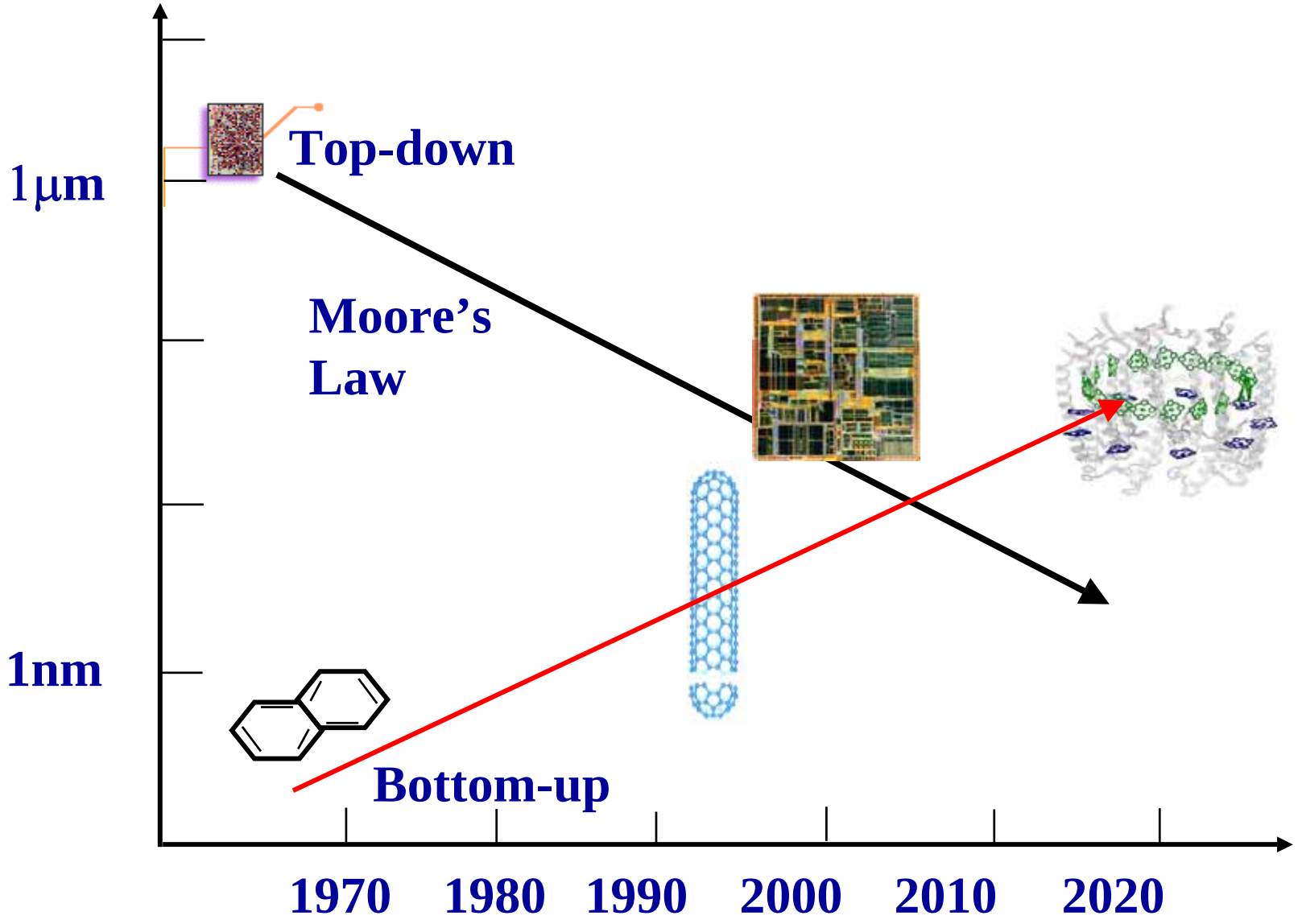
Government R&D Investment: FY2001

Nanotechnology : US$ 500 M



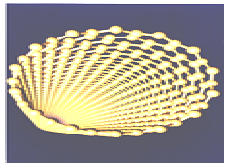
AIST

Crossover of Top-down and Bottom-up Technologies

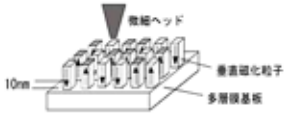


AIST

Materials

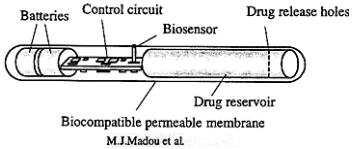


Carbon Nanotube

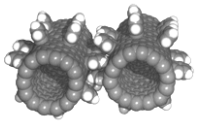


Ultra-hight density Storage

Life Sciences

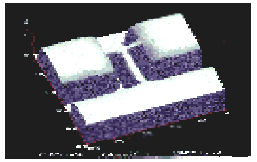


Drug Delivery

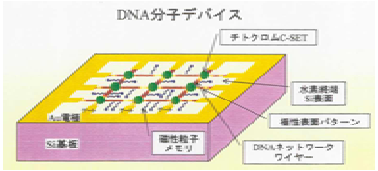


Molecular Machine

Electronics

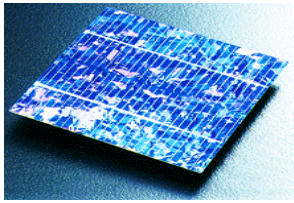


Single Electron Transistor

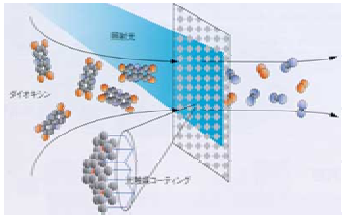


DNA, Quantum Devices

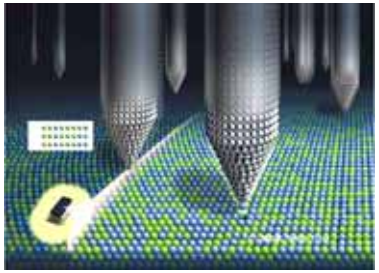
Environment Energy



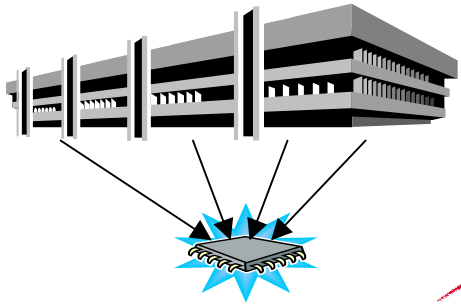
High-efficiency Solar Cell



Toxic Compound Filter



Manipulation of Matter with atomic and molecular precision

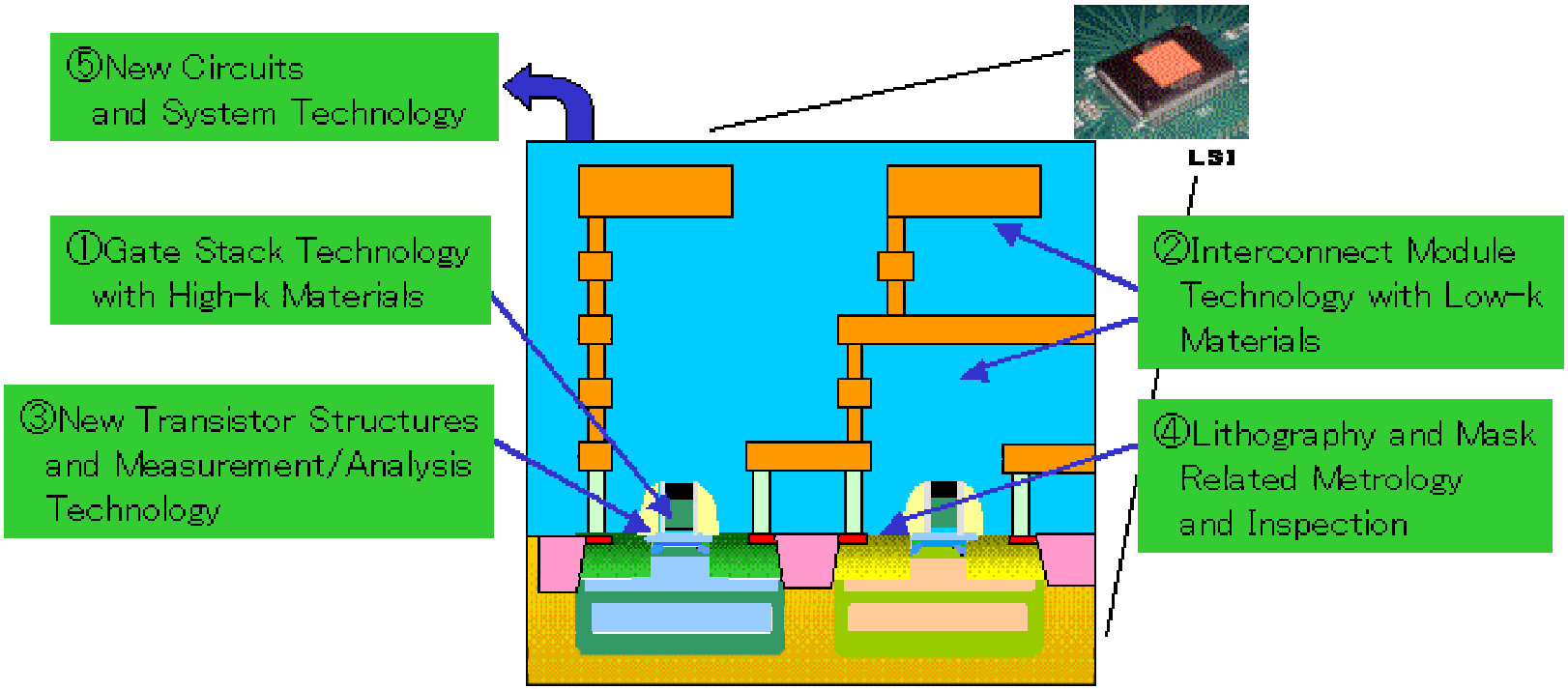


AIST

Next Generation Semiconductor Technology

- **Millennium Research for Advanced Information Technology (MIRAI) Project (FY 2001-2007)**

70-50nm node and beyond for SoC



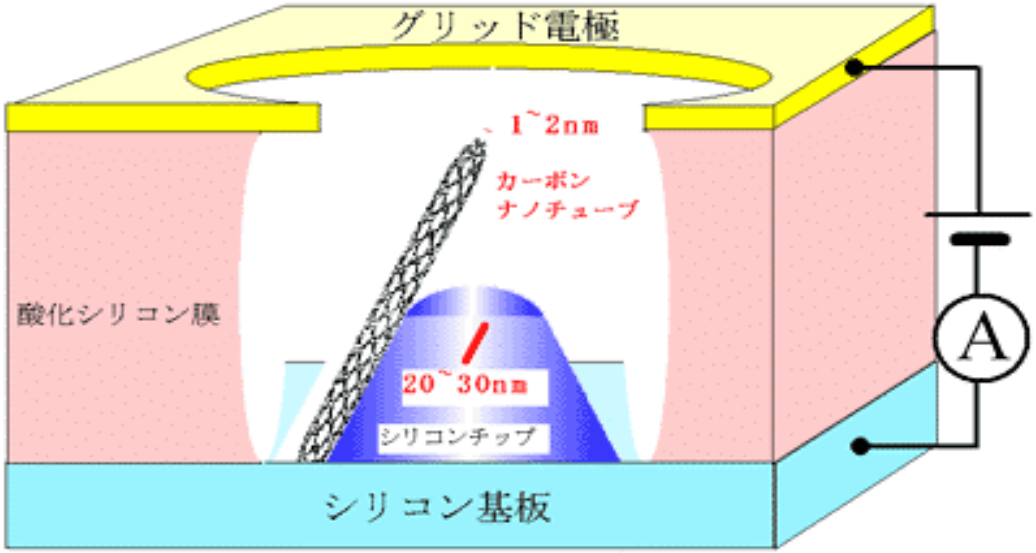
Schematic Cross Section of CMOS Transistor/Interconnect and Five R&D Focuses of MIRAI Project

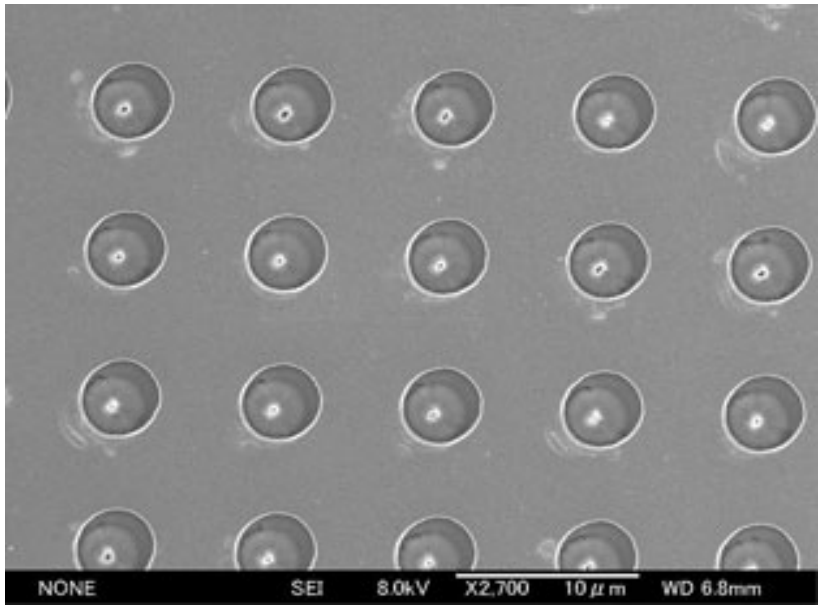
AIST

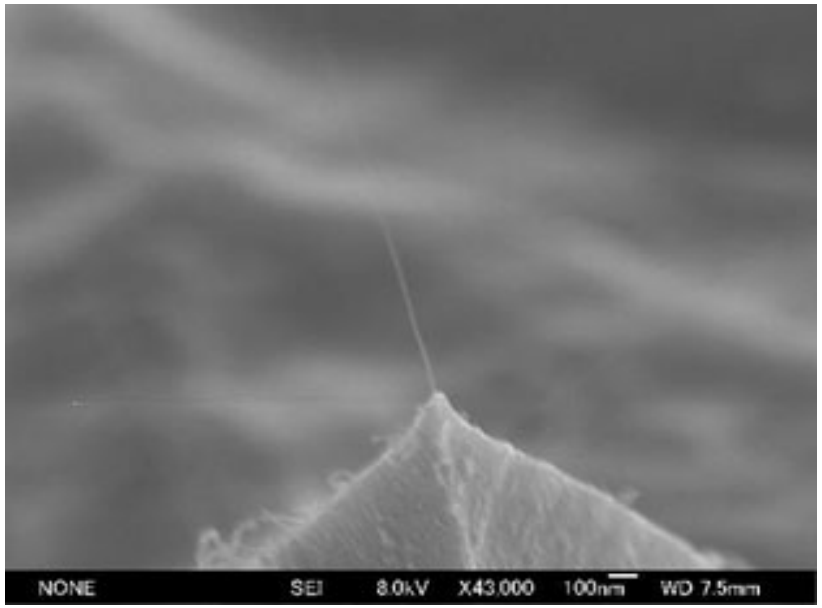
Noritake-Ise Electric／AIST　40-Inch CNT FED Panel

Nanotech 2003 + Future

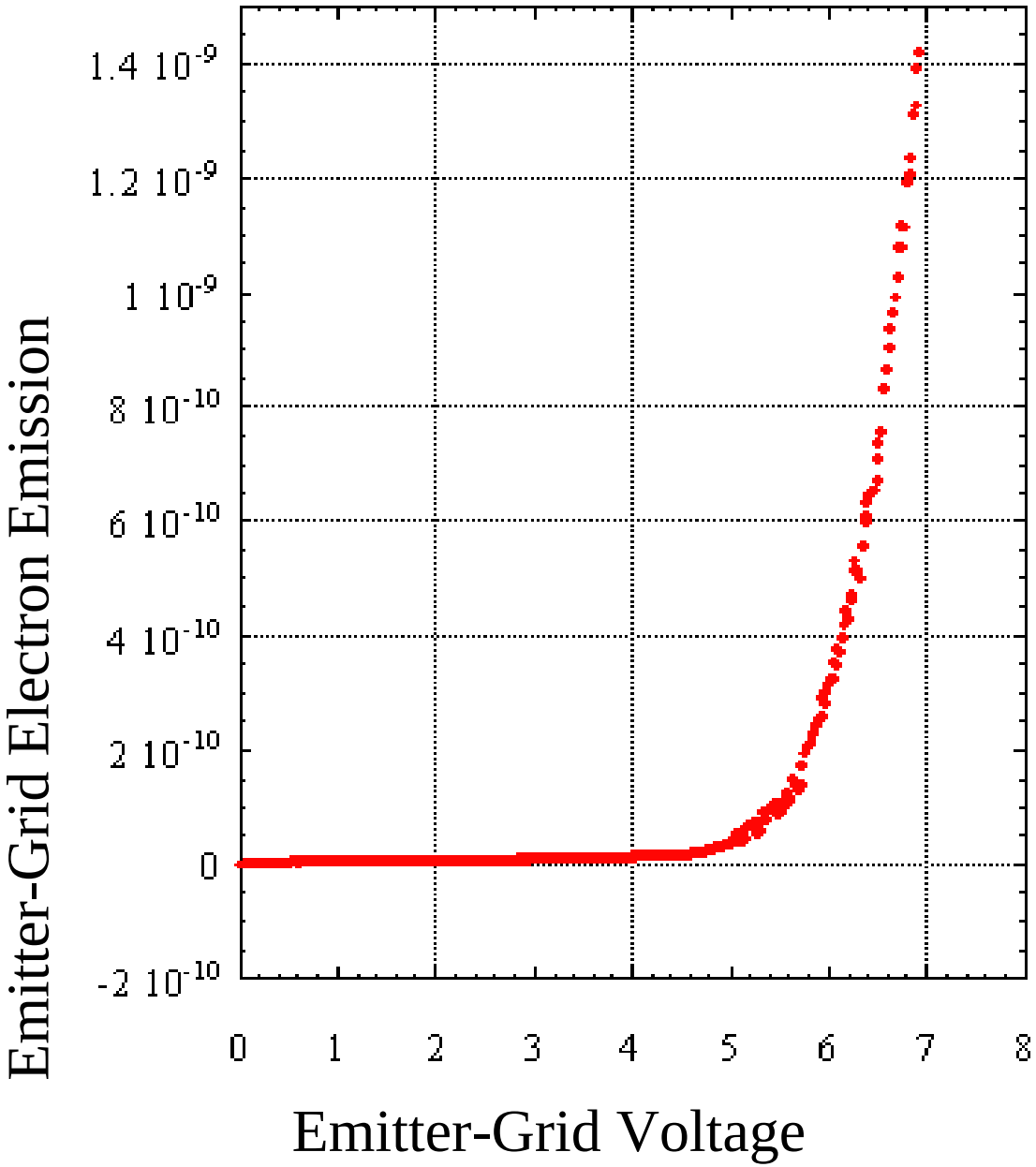
AIST


グリッド電極
1~2nm
カーボン
ナノチューブ
酸化シリコン膜
20~30nm
シリコンチップ
シリコン基板
A

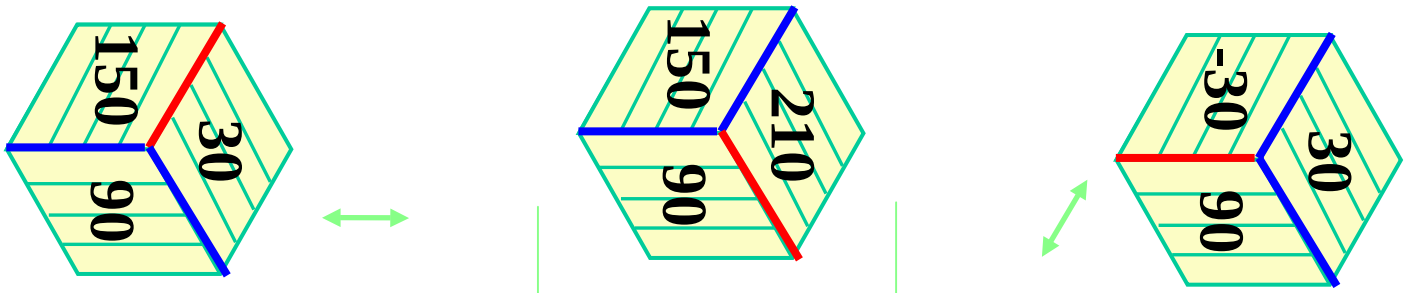

NONE SEI 8.0kV X2,700 10μm WD 6.8mm


NONE SEI 8.0kV X43,000 100nm WD 7.5mm

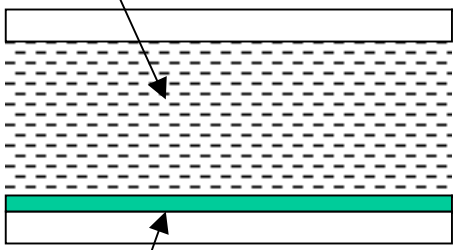
AIST


Emitter-Grid Electron Emission
1.4 10-9
1.2 10-9
1 10-9
8 10-10
6 10-10
4 10-10
2 10-10
0
-2 10-10
0
1
2
3
4
5
6
7
8
Emitter-Grid Voltage

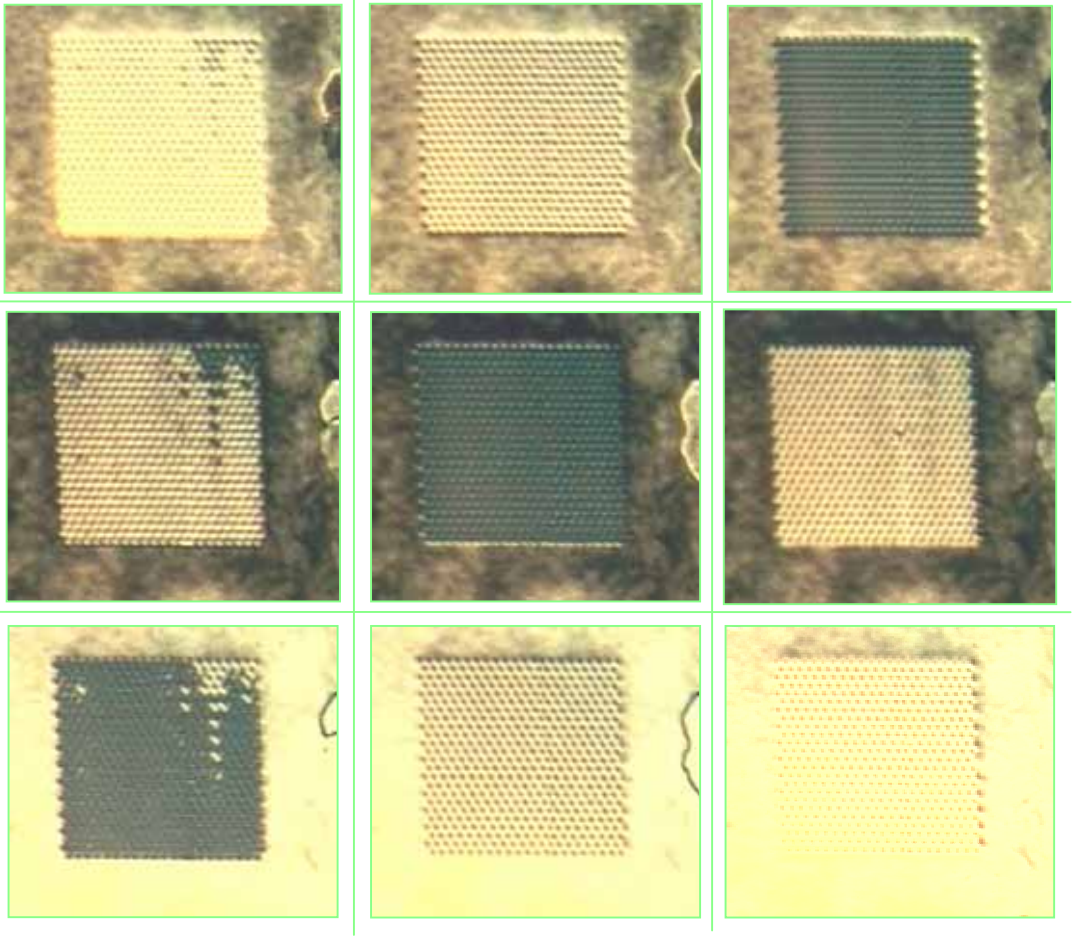
AIST



Liquid Crystal



Patterned Surface



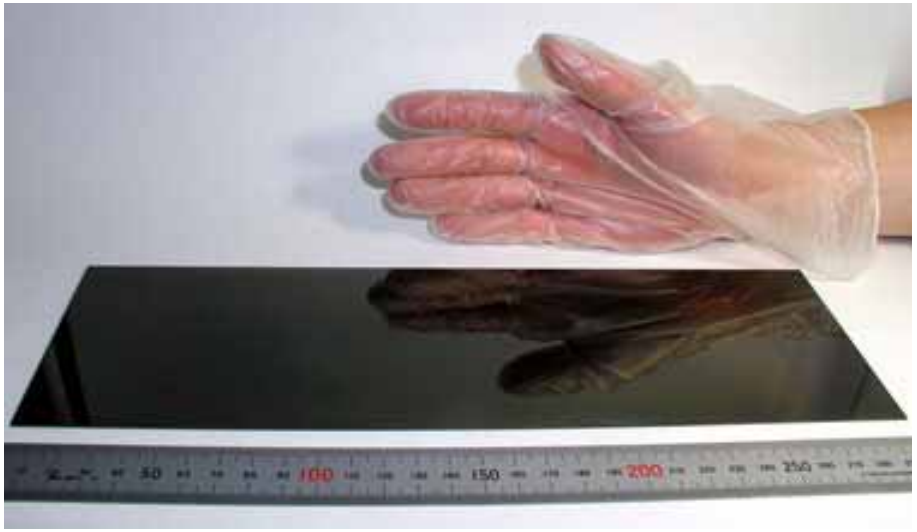
50μm

Nature, November 14, 2002.

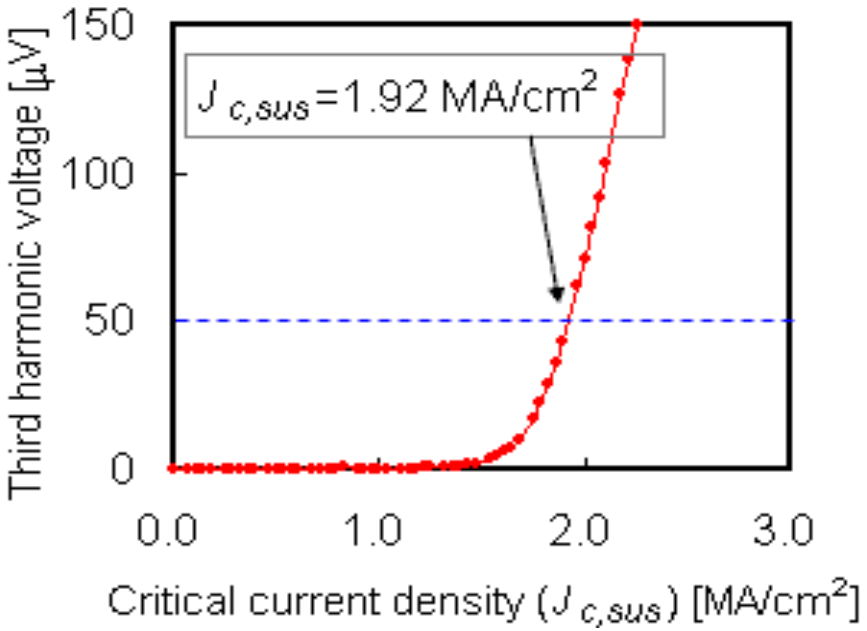
Sate1 State2 State3

AIST

The world's largest High-Tc superconducting film



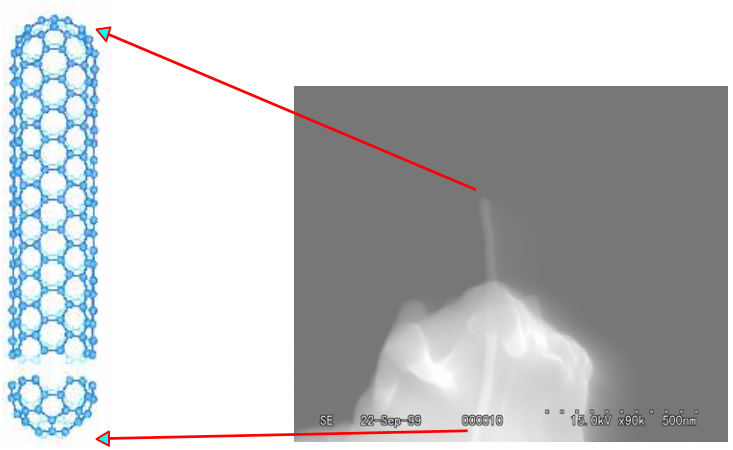
a) YBa2Cu3O7 superconducting film (30cm x 10cm) made by **coating pyrolysis process.**

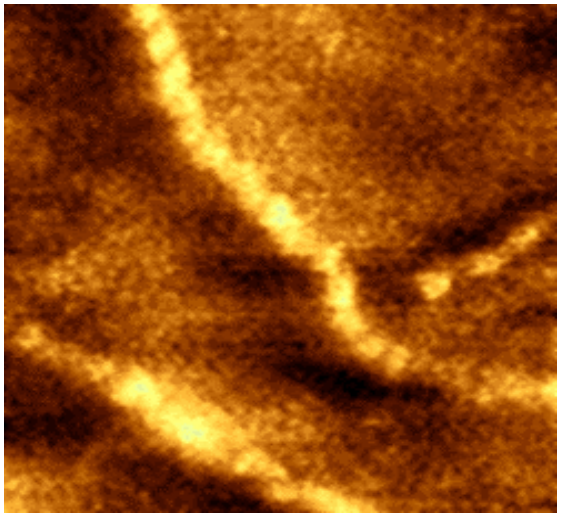


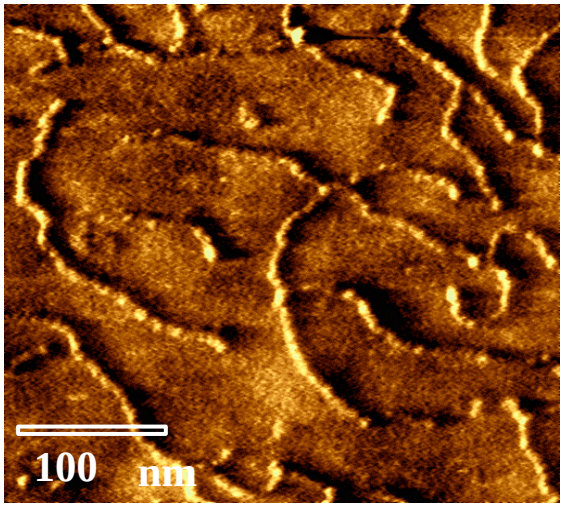
b) Superconductive characteristic of the film.

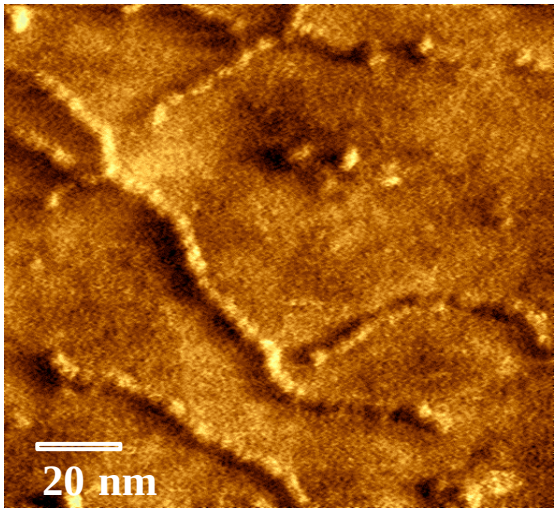
AIST

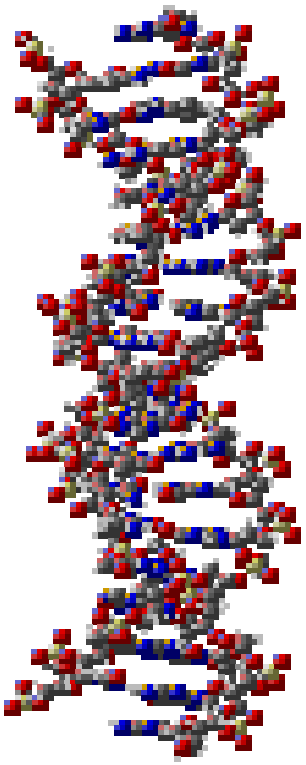
Use of Carbon Nanotube SPM Tip for DNA Imaging



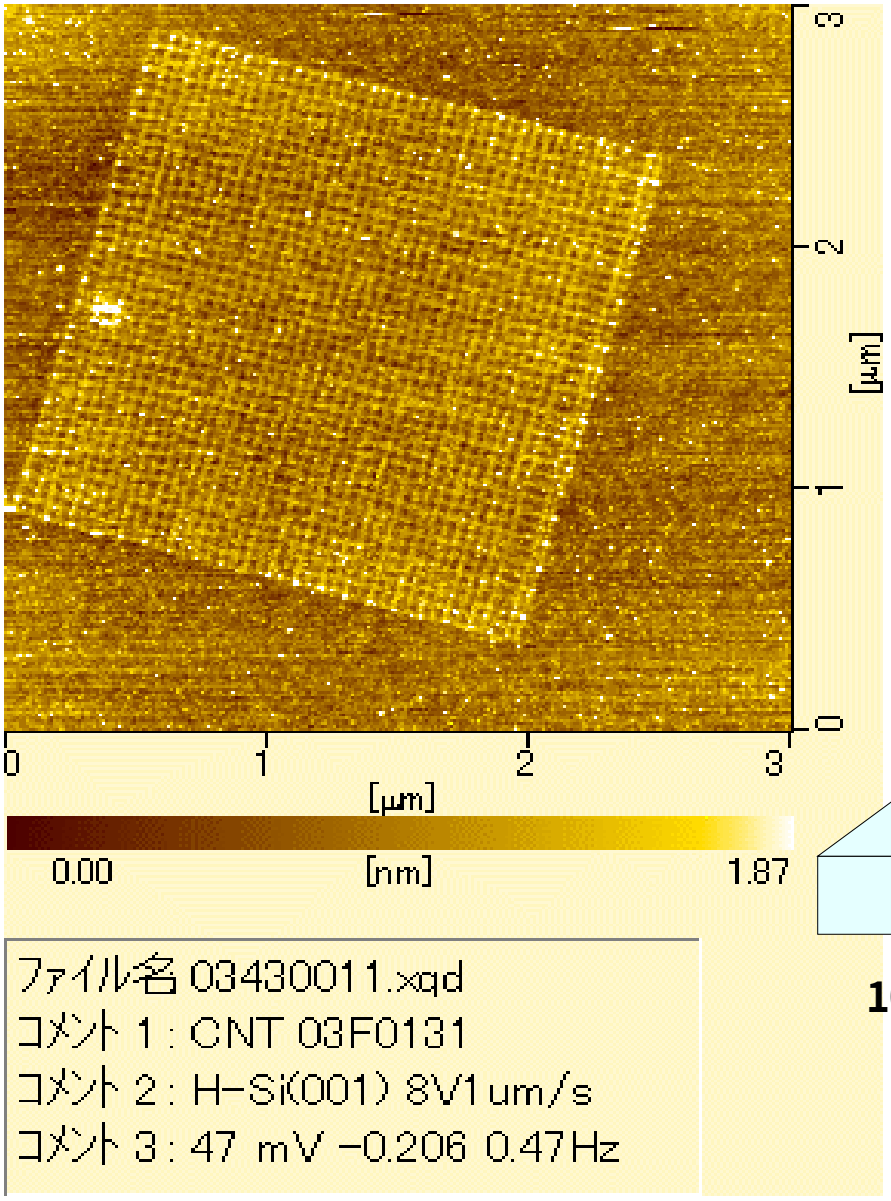


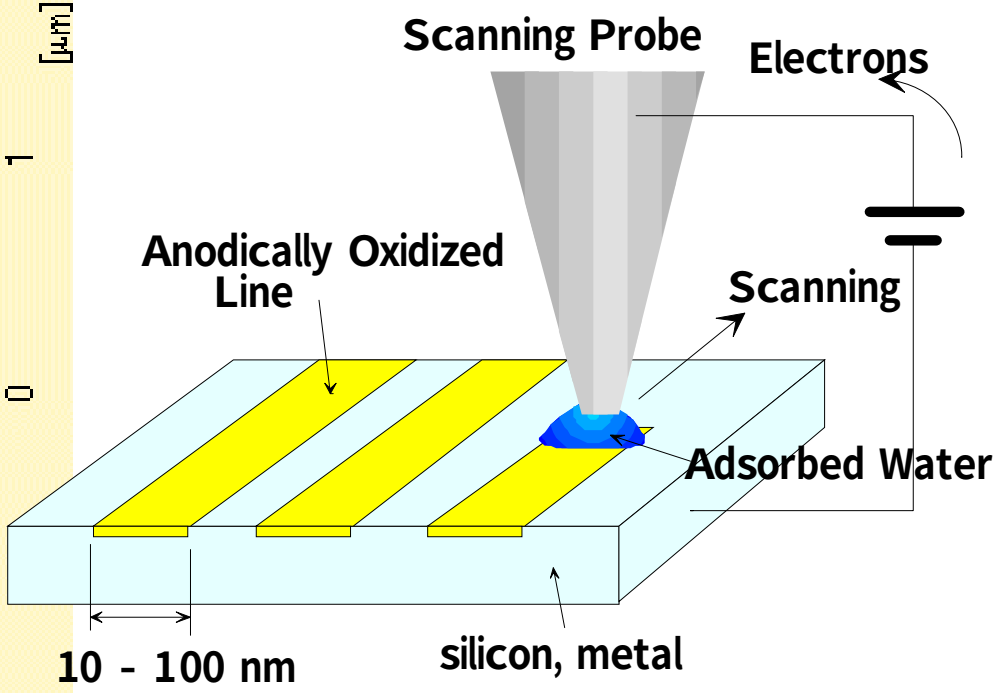






AIST

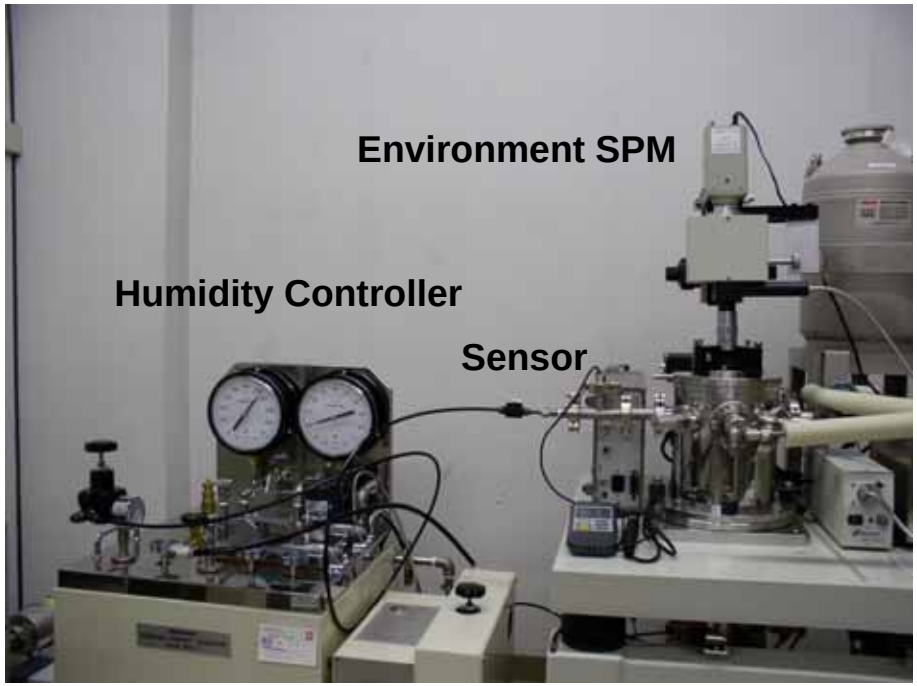




Oxide lines on n-type silicon.
10 V, 0.2 micron/s

AIST

Environment Control + *in situ* Current Measurement



Joint Development with Seiko Instruments

AIST