

The Role of Government Supporting Metrology, Standards, Science and Technology in the Development of Economies

Myungsoo Kim

President

KRISS

Korea Research
Institute of
Standards and Science

- 1 Economic Growth of Korea from Wasteland**
- government's initiative of S&T for economy
- 2 Government's Supports for Metrology and NMI**
- 3 Overview of KRISS**
- 4 Partnership with Industry and Success Stories**
- 5 Future Perspectives**

Economic Growth of Korea (1)

Grown up to be
**World's 8th Largest
Exporter** today

Construction
Burj khalifa (Dubai)

Petrochemicals

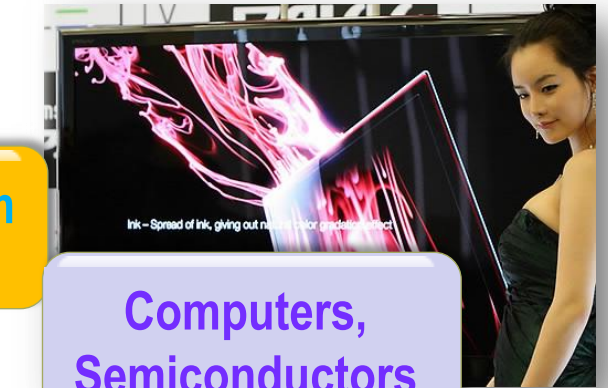
Steel

**Wireless Telecom
Equipment**

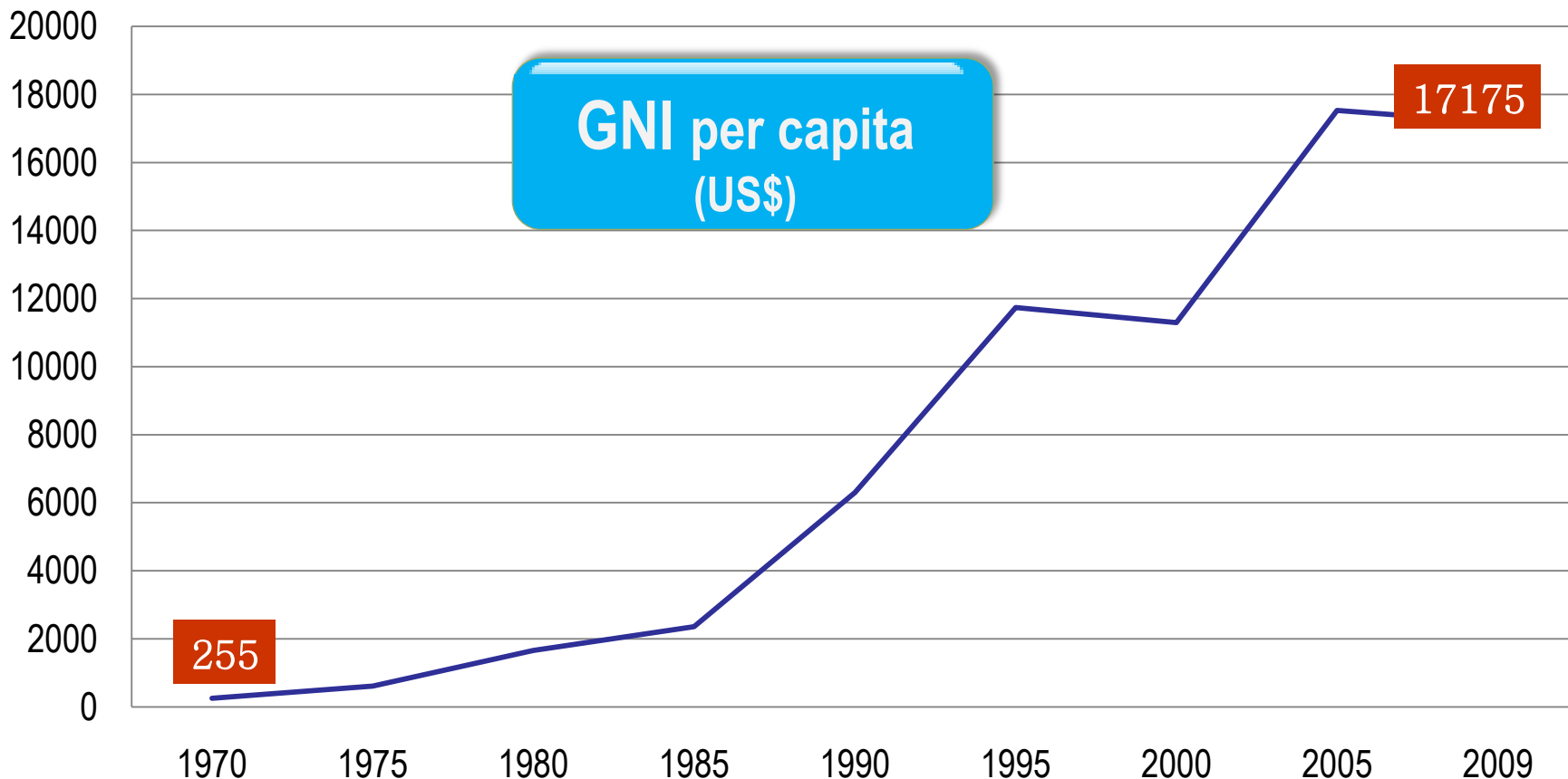
Shipping building

**Computers,
Semiconductors**

Automobile



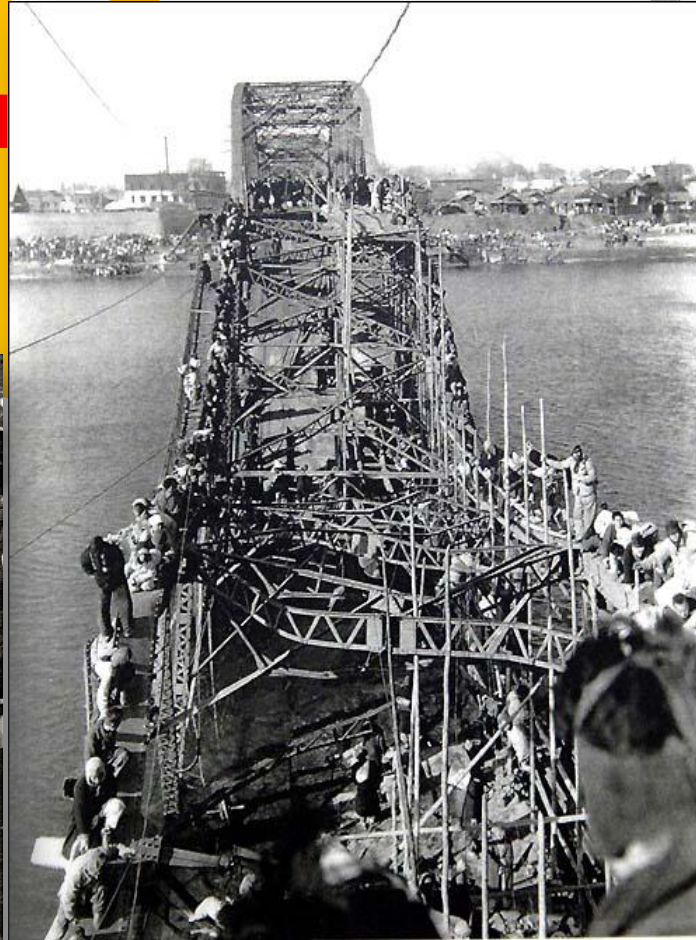
Economic growth of Korea (2)



Year	'70	'75	'80	'85	'90	'95	'00	'05	'09
GNI per capita (US\$)	255	607	1,660	2,355	6,303	11,735	11,292	17,531	17,175

- *US\$79 (1960): second to the lowest in the world (* increased more than 200 times for 50 years:1960-2009)*

From Wasteland
in 1950's
after Korean War



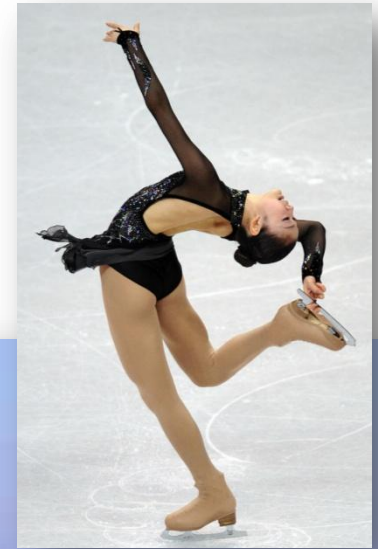
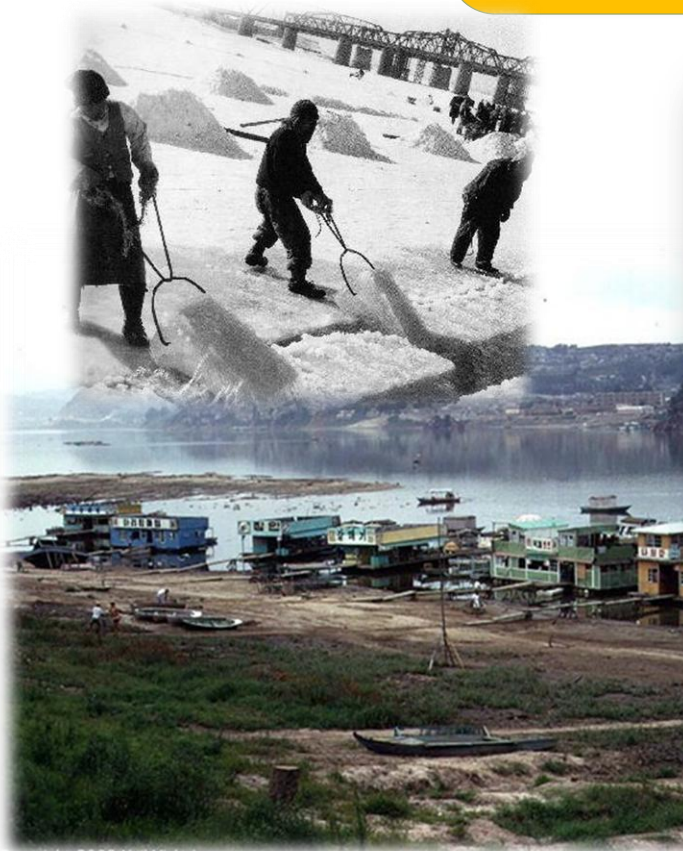
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북리군의 기습 남침



The Korean War destroyed almost everything in the Korean Peninsula (1950-1953), leaving **nearly no resources available for growth...**

That's why it might be called
"the Miracle on HAN river!"



- **Government's Initiatives**
- **Strong Leadership of President**
- **Enthusiasm for Education**
- **Diligence of Korean People**
- ...

Key driving force
for today's economic
prosperity of Korea

Series of 5-year
Economic Development Plans
(1962~1987)

Series of 5-year
S&T Development Plans
(1962~1987)

Characteristics of S&T Development Plans in Korean in 60's-70's

① **Setting up S&T Development Plans**
Together with and in support of
Economic Development Plans

② **Establishment of GRI's**
- **Government-supported Research Institutes**
(26 GRI's in operation)
- To be professional organization in each specific area of S&T

③ **Offering good environment for GRI's**
- Independent legal status of GRI's
- Continued financial support

④ **Recruiting the Brain**
- Attracting Korean scientists who studied abroad to come back
- Higher salary scale: 3 times of professors

1960's (2)

과학기술정보연구원 (KISTI, 1962)
KIST (1966)

1970's (9)

원자력연구원 (KAERI, 1973)

해양연구원 (KORDI, 1973)

표준과학연구원 (KRISs, 1975)

ETRI (1976)

화학연구원 (KRICT, 1976)

기계연구원 (KIMM, 1976)

전기연구원 (KERI, 1976)

지질자원연구원 (KIGAM, 1976)

에너지기술연구원 (KIER, 1977)

1980's (7)

건설기술연구원 (KICT, 1983)

생명공학연구원 (KRIBB, 1985)

천문연구원 (KASI, 1986)

식품연구원 (KFRI, 1987)

기초과학지원연구원 (KBSI, 1988)

항공우주연구원 (KARI, 1989)

생산기술연구원 (KITECH, 1989)

1990's (2)

한의학연구원 (KIOM, 1994)

철도기술연구원 (KRRI, 1996)

2000's (6)

안전성평가연구소 (KITOX, 2002)

극지연구소 (KOPRI, 2003)

국가수리과학연구소 (NIMS, 2005)

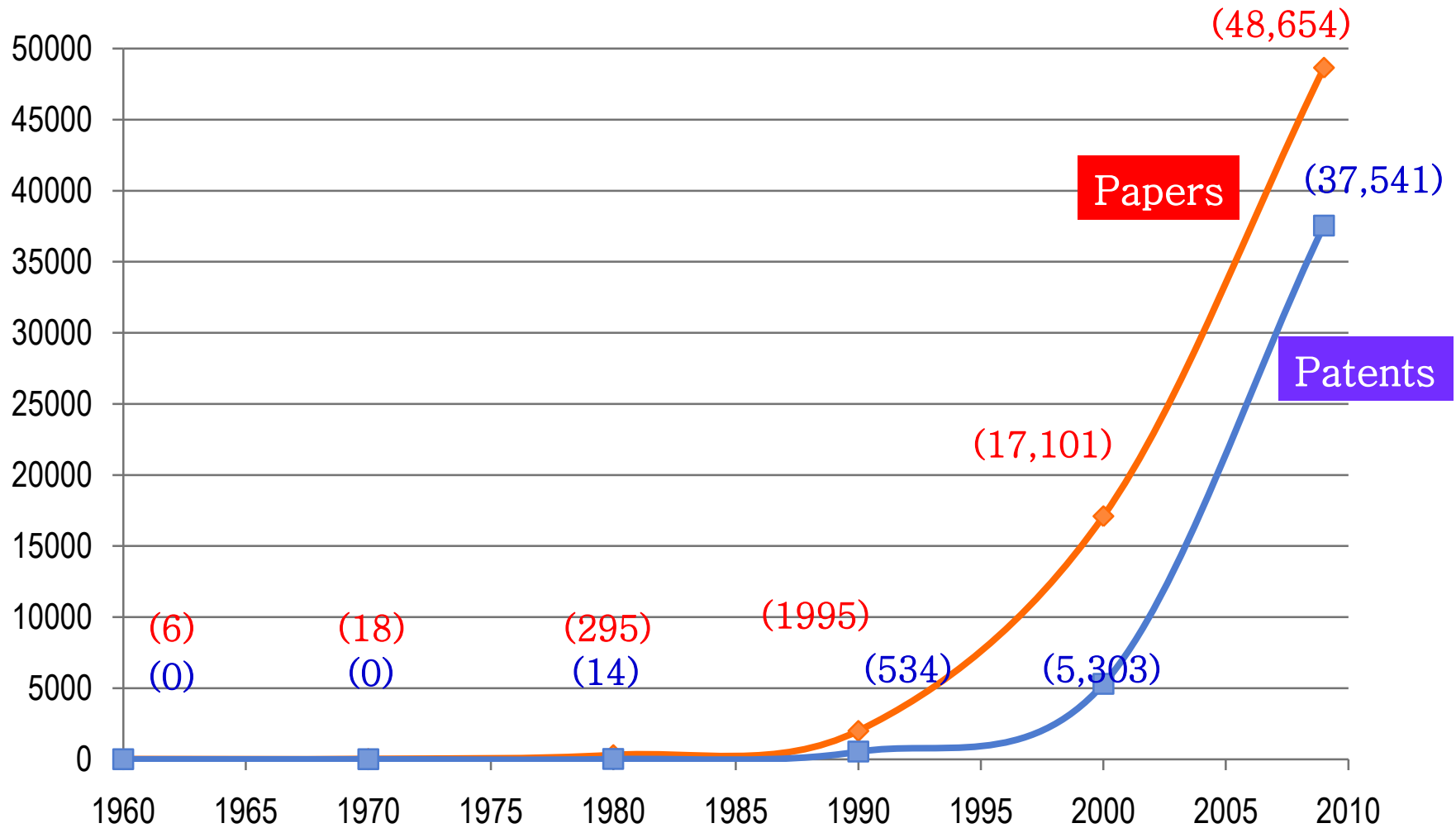
국가보안기술연구소 (NSRI, 2005)

핵융합연구소 (NFRI, 2005)

재료연구소 (KIMS, 1976, 2007)

Government-supported Research Institutes
(26 GRI's in operation)

Rapid Growth of Papers and Patents



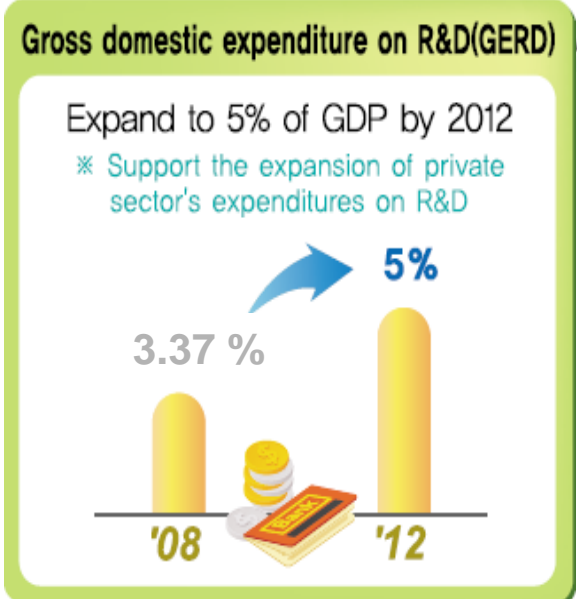
<http://www.scopus.com>

Invest 5% of GDP on S&T by 2012

•Including US\$135 billion from government

Nurture 7 major technology areas

Becoming one of 7 major S&T powers in the world



- 1 Economic Growth of Korea from Wasteland
- 2 **Government's Supports for Metrology and NMI**
- Providing continued resources;
- 3 Overview of KRISS
- 4 Partnership with Industry and Success Stories
- 5 Future Perspectives

Creating KRISS as NMI of Korea in 1975

- To support export-driven economy;
- By providing reliability of exported products of Korea

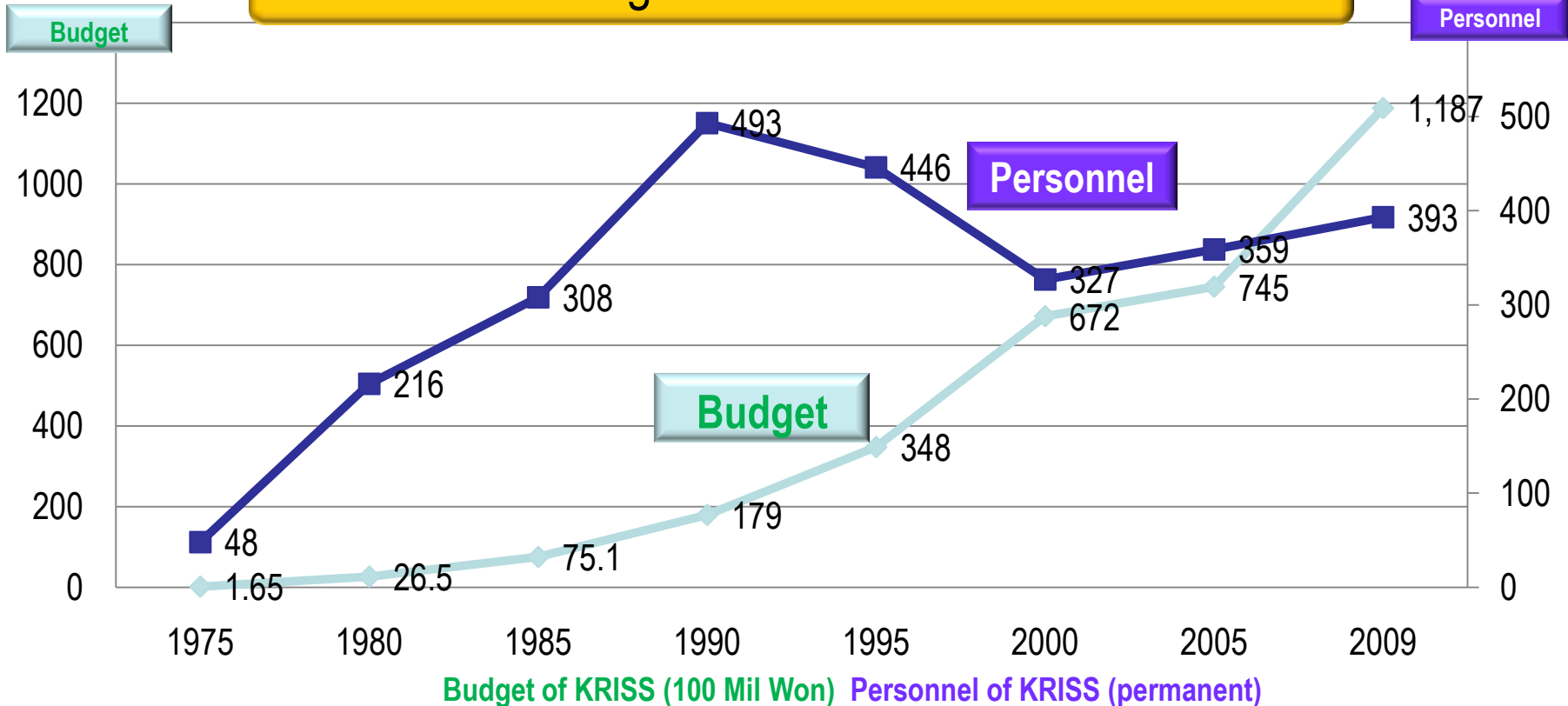


Groundbreaking Ceremony



Early Stage of Constructing KRISS campus

Ever increasing Financial & Human resources



ACCOUNT	'75	'80	'85	'90	'95	'00	'05	'09
GNI per capita (U\$)	607	1,660	2,355	6,303	11,735	11,292	17,531	17,175
Budget (100 Mil Won)	1.65	26.5	75.1	179.4	347.5	671.7	744.9	1,187.4
Personnel (Permanent)	48	216	308	493	446	327	359	393

Buildings	Area	Years of Construction	Investment (Mil Won)
Administration	7,967 m ²	'79	762
Physics	6,312 m ²	'79	670
Mechanics	2,771 m ²	'79	248
Chemistry	4,073 m ²	'87	1,214
Precision Instrumentation	4,489 m ²	'87	1,219
Applied Physics	6,090 m ²	'92	2,017
Materials Evaluation	6,720 m ²	'94	3,954
Technology Services	5,083 m ²	'99	6,527
Structural Integrity	6,511 m ²	'01	9,290
CRM	6,048 m ²	'05	9,997
Guesthouse	3,507 m ²	'06	4,493
Advanced Research	9,421 m ²	In progress ('10~'13)	35,000

Map of KRISs Campus today

Total Area : 500,147 m²



- 101 행정동
- 102 식당동
- 103 중앙기계실
- 106 기숙사
- 107 산학협력지원시설동
- 136 불우장비창고
- 201 물리동
- 202 계측기기동
- 203 응용물리동
- 204 역학동
- 205 무진동실
- 206 안전계측동
- 207 구조시험동
- 208 비저성동
- 209 고압가스유량동
- 210 표준주파수국
- 211 인증표준물질(CRM)동
- 212 전자파야외시험장
- 213 수소 안전동
- 301 신소재동
- 302 기술지원동
- 306 화학동
- 307 가스분석동
- 238 대형광학가공동
- 501 과학기술연합대학원대학교

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- 3 **Overview of KRISS**
- R&D activities, global partnership
- 4 Partnership with Industry and Success Stories
- 5 Future Perspectives

Mar 2008

Affiliated with Korea Research Council of Fundamental Science and Technology under the Ministry of Education, S&T

Oct 2004

Affiliated with Korea Research Council of Public Science and Technology

Feb 1999

Officially designated by law as **NMI of Korea**

Framework Act on National Standards

Oct 1991

Renamed as **KRISS**

Korea Research Institute of Standards and Science

May 1979

Began **Calibration Services**

Dec 1975

Established as **KSRI**

Korea Standards Research Institute



Sept 1980

Constitution (Article 127 - Clause 2)

“The State shall Establish National Standards System!”

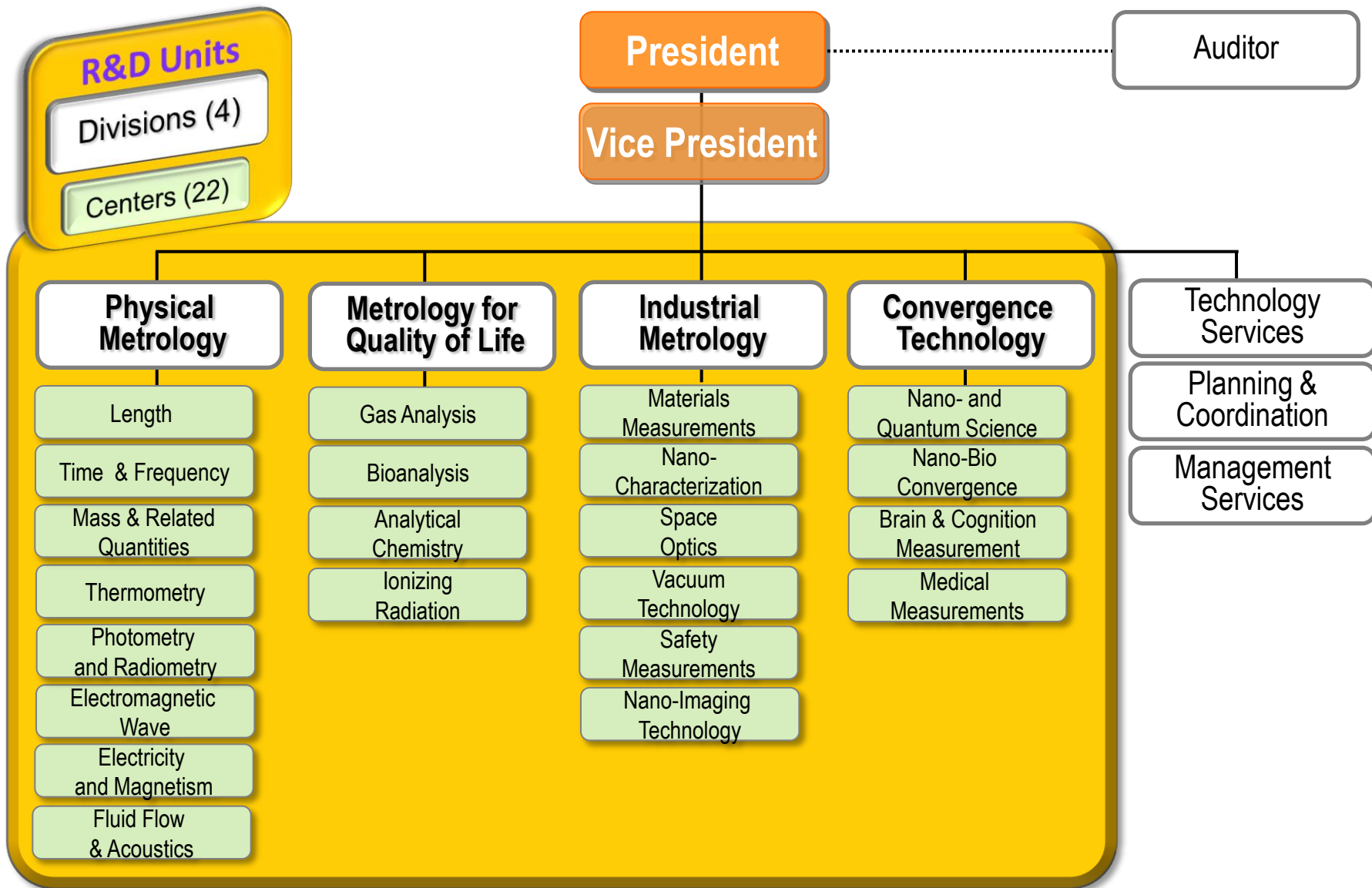
Feb 1999

Framework Act on National Standards (Article 13)

- ➔ Officially designated KRISS by law as **NMI of Korea**
- ➔ To join **CIPM MRA**



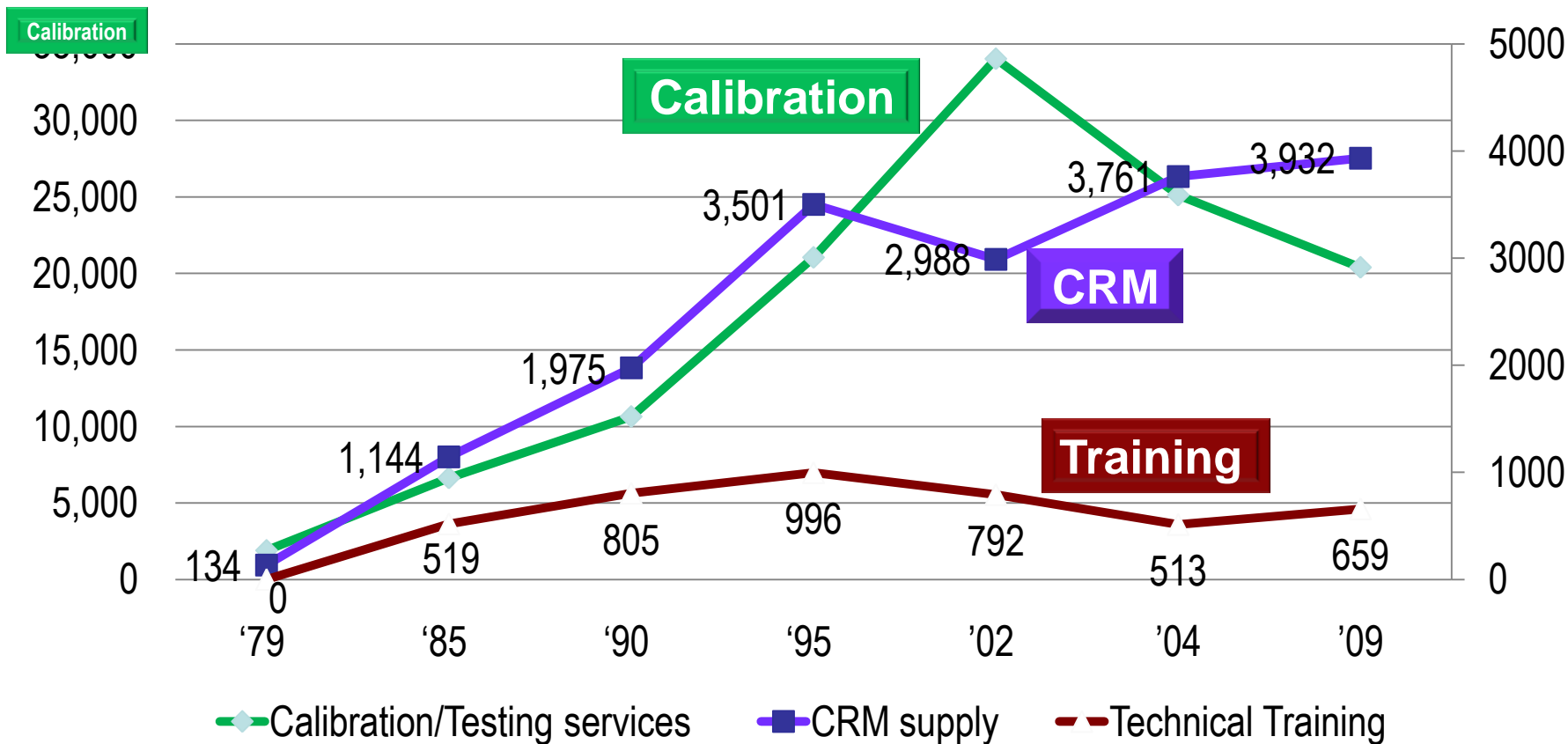
Organization Chart



- 700 **employees** (393 permanent staff, 229 researchers, 214 Ph.D.'s)
- 110 million US\$ **budget** in FY 2010
- 230 **papers** published in SCI journals in 2009
- 220 **patents** applied in 2009 (including 70 for overseas)



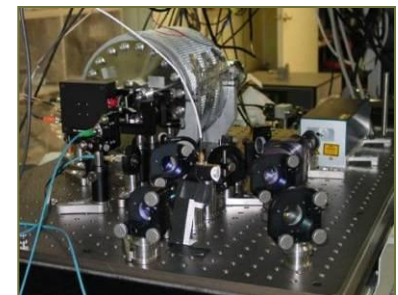
Service to Industry



Items	'79	'85	'90	'95	'02	'04	'09
Calibration/Testing	1,891	6,630	10,641	21,043	34,025	25,113	20,393
CRM	134	1,144	1,975	3,501	2,988	3,761	3,932
Technical Training		519	805	996	792	513	659

“KRIS, one of the leading NMIs”

- **Establish and improve measurement standards**
 - Participation in **294 items of Key Comparisons**
 - Registration of **957 items of CMC's**
(KCDB as of Oct 2010)
- **Recognized performance in some physical metrology**
 - **Mass, LED intensity, Frequency**, etc.
- **R&D on next generation measurement standards**
 - **Atomic fountain frequency standard**



“KRISS, working towards better standards for better quality of life”

Measurement standards for the **environment and food**

- International equivalence of the environmental measurement
- Top quality standards for **greenhouse gas** measurement
- Developed **287 items of environmental CRMs**

Measurement standards for **health**

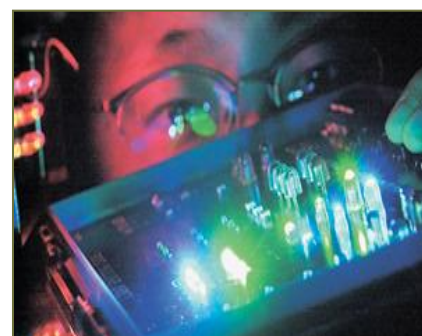
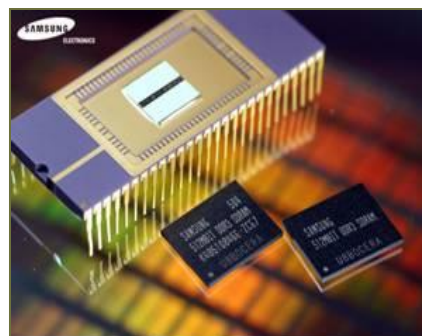
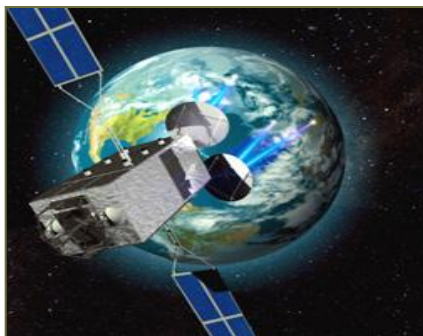
- National standards for clinical diagnosis and biomolecule
- Developed **97 items of clinical CRMs**

580 items of
KRISS CRMs



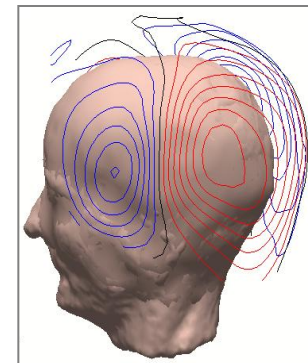
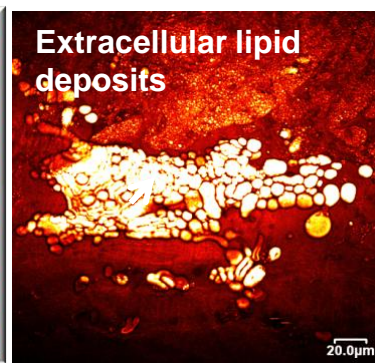
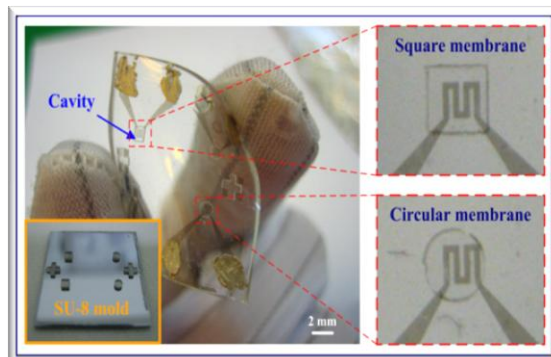
"KRISS, exploring cutting-edge industrial technology"

- **Cutting-edge measurement technology** to enhance the global competitiveness of industries, such as:
 - **space optics, vacuum, advanced instrumentation**, etc.
- **Total measurement solutions** for safety and security in **energy sectors**
- **Measurement technologies** for **public safety**
- **Measurement capabilities** in the fields of **nano-materials**



“KRISS, studies on emergence and convergence technologies”

- SI traceable single **quantum-based standards** for current, force, noise thermometry, and optical lattice clock.
- Technologies for a precision measurement based on quantum mechanical nature of micro/nano scale system
- **Nano-bio technology** for label-free, real time, and biochemical imaging
- **Brain and Cognition** Measurement



Global Partnership - Partners abroad KRISs



Collaborations with more than 40 partners over the world

Collaboration between CENAM and KRISs

- Exchange of MoU: March 2001, March 2007
- Exchange of Experts (2002-2004)
 - from CENAM to KRISS: 10 experts
 - from KRISS to CENAM: 11 experts

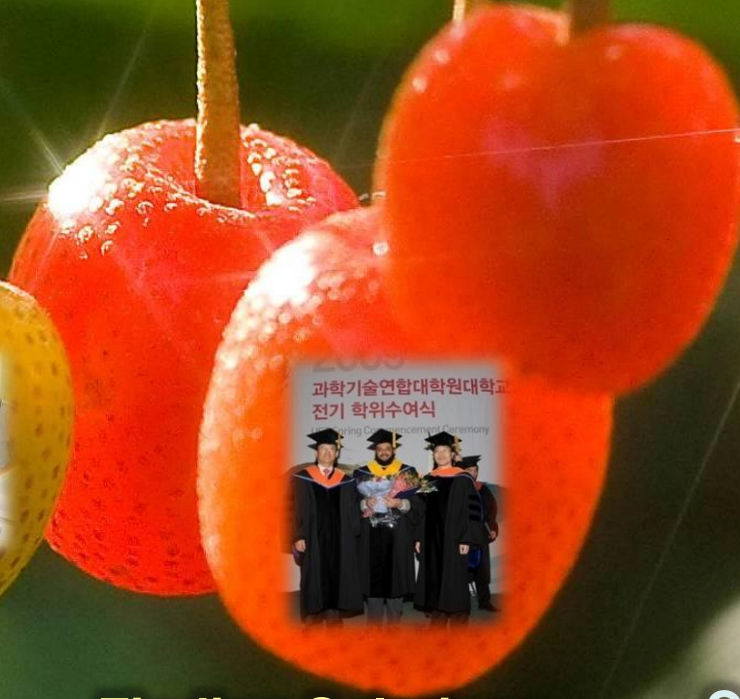
Research cooperation
Bilateral comparison
Peer review



Partnership of KRISS pursues



**Sharing Fruits of
Shared Effort
with Partners**



**Finding Solutions
to National & Global
Issues in Metrology**

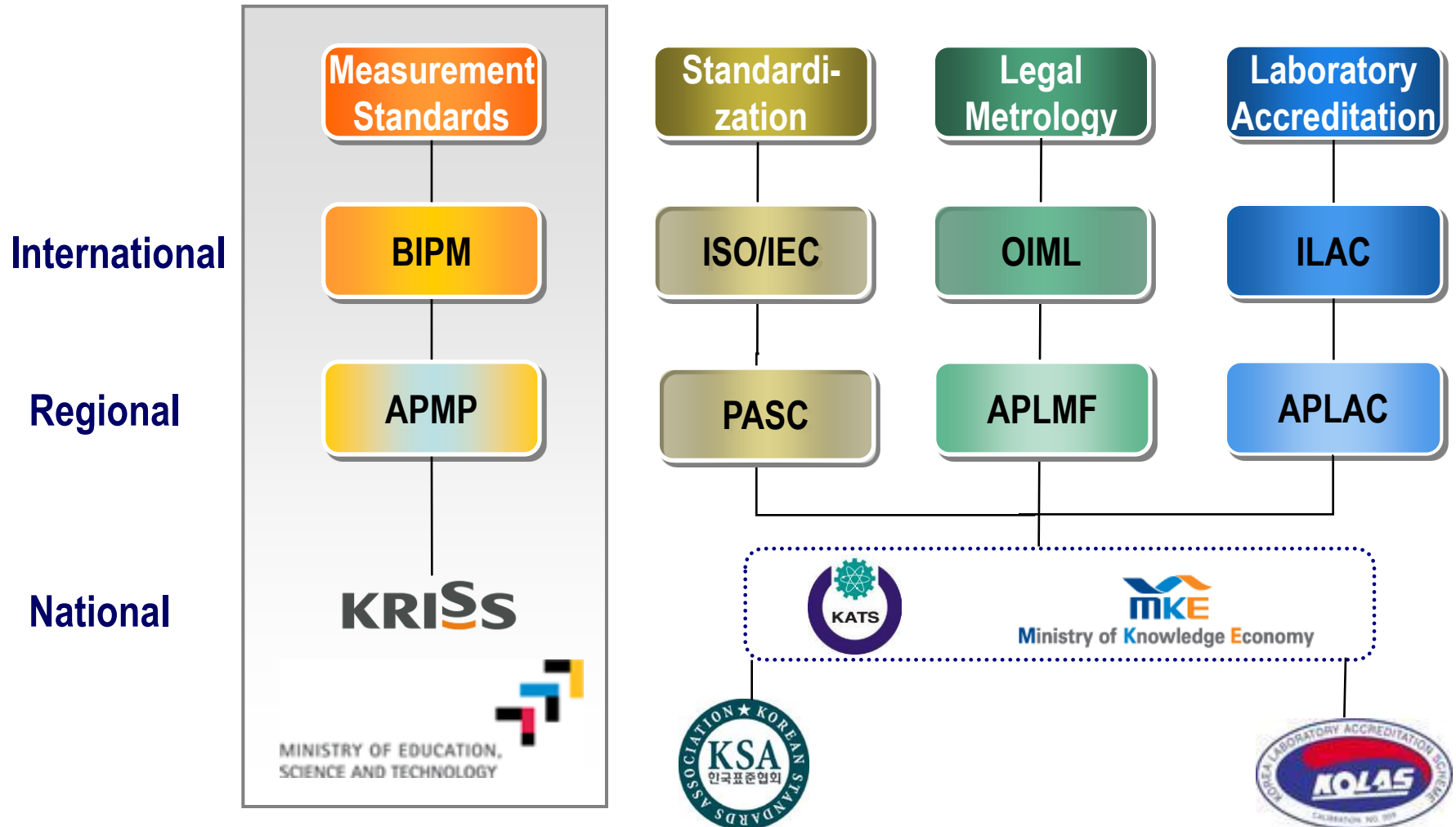


**Creating More Values
to Customers at Home
& Partners Worldwide**

KRISS

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- 2 Government's Supports for Metrology and NMI
- 3 Overview of KRISS
- 4 **Partnership with Industry and Success Stories**
- Providing measurement solutions to customers
- 5 Future Perspectives

National Standards System in Korea KRISs



Promoting close and effective linkages among the organizations engaged in different areas of national standards system

- APMP** Asia Pacific Metrology Program
- PASC** Pacific Area Standards Congress
- APLMF** Asia Pacific Legal Metrology Forum
- APLAC** Asia Pacific Laboratory Accreditation Cooperation

“Traceability for Innovation towards Competitiveness”

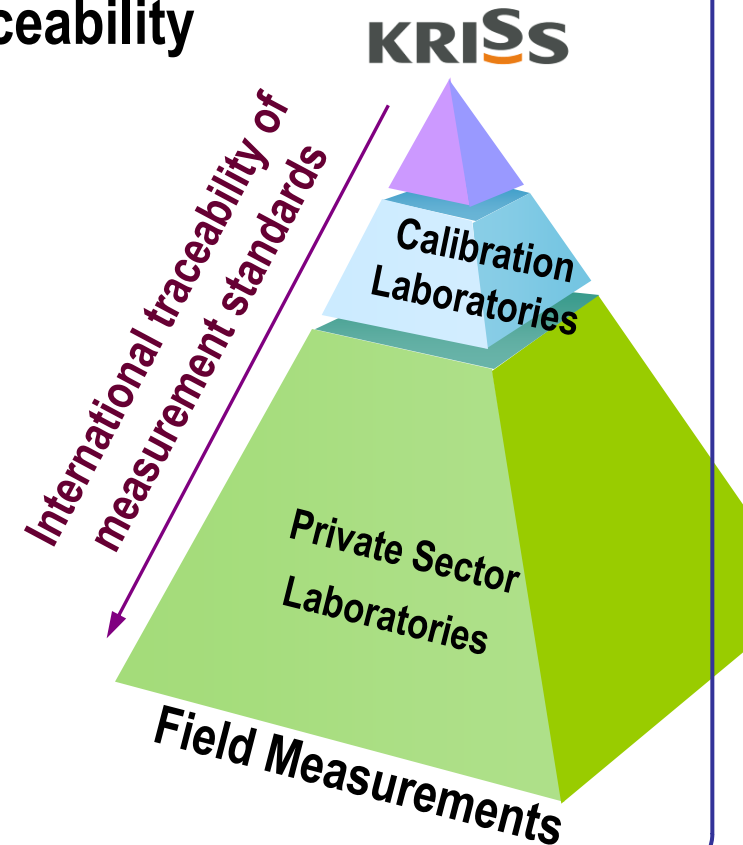
High quality services stimulating innovation of Industry based on internationally recognized traceability

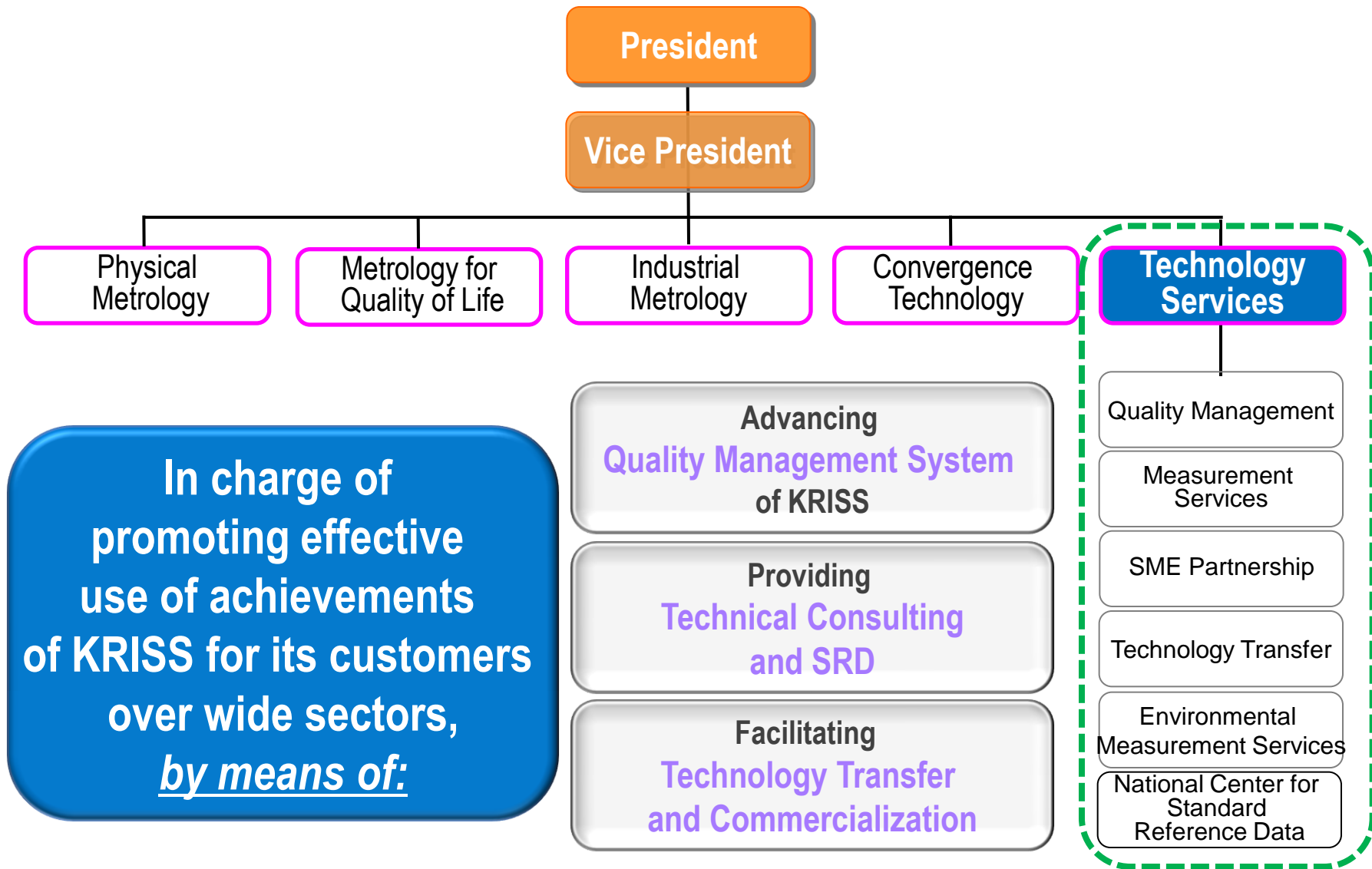
- Calibration, testing and technical consulting
- Development of CRMs for industry
- Training and education on precision measurement

Services provided by KRISS (2010)

Calibration	Testing	CRMs	Training
17 742	3 288	2 255	579

Covering over 3 000 customer organizations





Portfolio of Better Serving Customers KRISs

Ever-growing Satisfaction
of Customers

Efficient and Advanced
System of Services

Calibration,
Test,
CRM

Measurement
Clubs

Home
Doctors

Technical
Advice,
Information

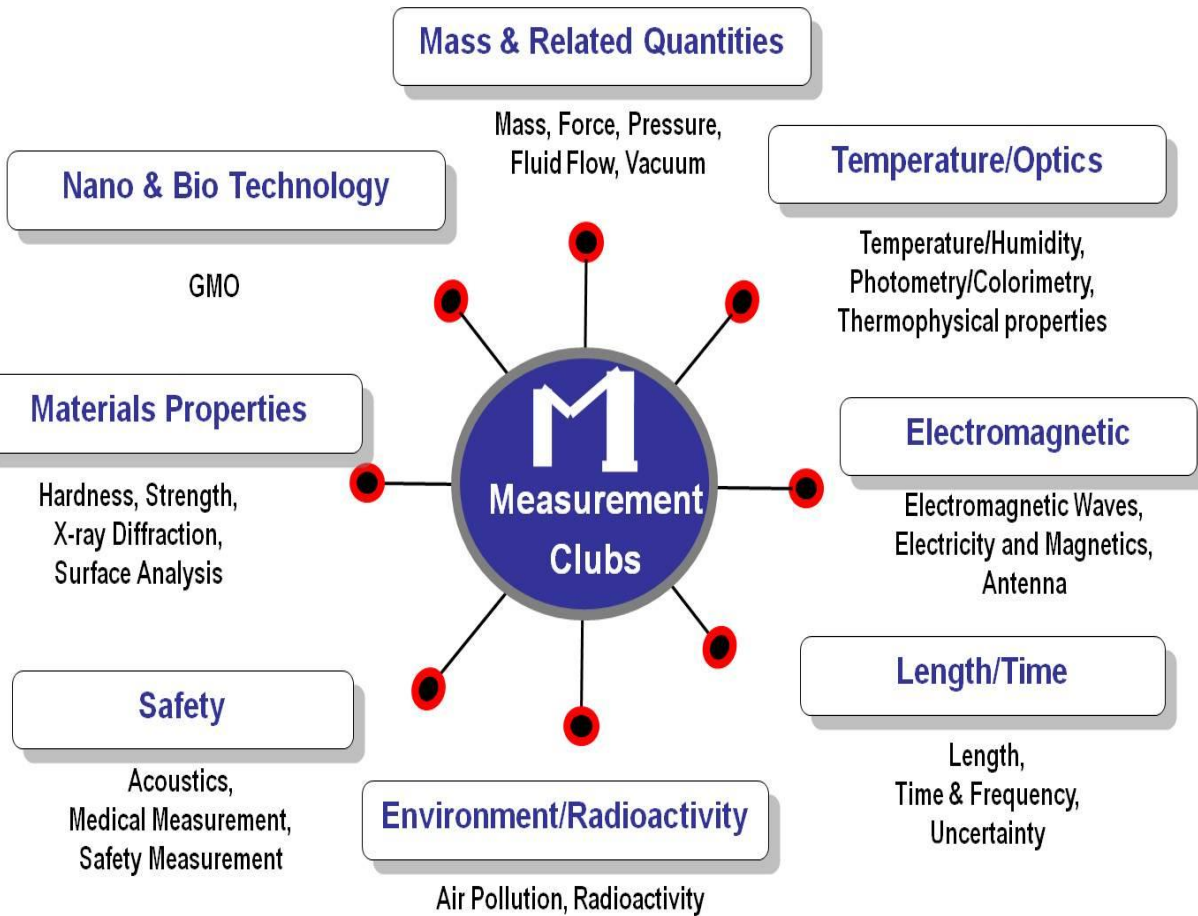
Education,
Training

Reference
Data

**24 special interest groups
over 5,700 members.**



< Measurement Club Workshop >



KRISS Measurement Clubs

- Experts from **Industry, Academia, Government, Research Institutes** get together;
- Holding **on/off-line meetings** for networking;
- **Sharing knowledge and experience** of measurement technology

Visiting client companies (4-6 times/year)

- To find technical problems and to provide consulting on site

Inviting client companies to KRIS

- To conduct experiments with KRIS facilities

Providing education/training for client companies

On-line communication offering recent technical news



Major fields	Consulting technologies
<ul style="list-style-type: none"> • Mechanical measurements • Electricity & magnetism • Semiconductor manufacturing facility • Material evaluation • Optics 	<ul style="list-style-type: none"> • Ultrasonic flowmeter, thermometer, Laser technology for length measurement • Current transformer, oscilloscope, switches for rail-road system, amplifier for audio system, hard disk driver, antenna • Vacuum pump, chemical vapor pressure, precursor materials • Non-destructive test, bridge safety test, concrete hardness test • Optical photometer

Success Stories of Home Doctor Program KRISS

Contribution to Sales Increase (11), and local Production (8)

- CT e-Tech Co. → HYUNDAI Heavy Industry
- Excitation test of 30 A current transformer: Reduction of noise



Contribution to Quality Control

- Daedock Tech Co.
- Consulting design of flowmeter appropriate for installation



Commercialization of Instruments

- Dasol Engineering Co.
- Surface resistance measurement, developing four-point probe



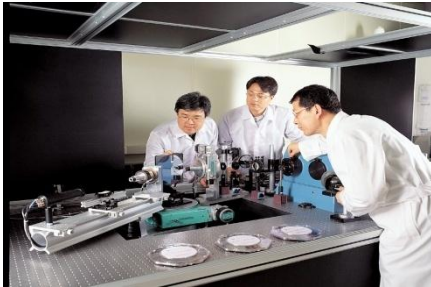
Benefits for KRISS Experts

- Developing new technical consulting projects on payment
- Producing patents (4), developing national R&D projects (2)



- **Thin film thickness:** Key metrological challenge in Semiconductor Industry

KRISs provided solutions by developing **CRMs**
capable of measuring thickness of ultra-thin film SiO_2/Si (**< 1 nm**)



Using KRISs High-Accuracy Ellipsometer



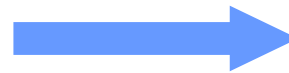
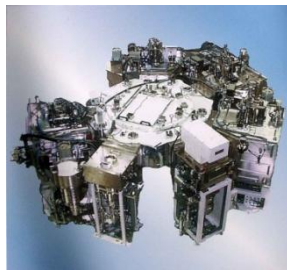
Developed CRM for measuring thickness of thin film



Used for Calibration of Measuring thickness of thin film

- **Vacuum processing in Display industry**

→ **Key role in quality control, process innovation, productivity improvement**



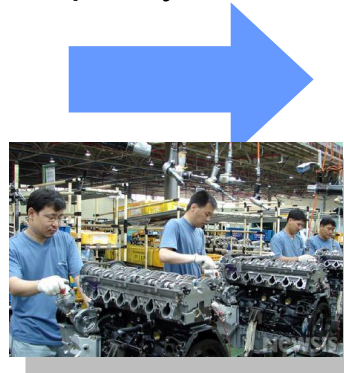
Vacuum Process in Fab. : 80 %
Korea Vacuum Market Value: > \$ 60B/year (ave. 8 % of world wide)

For SAMSUNG Electronics

Measurement Solutions for Automobile Industry

- **Torque control** in Automobile assembling

- Key role for automobile quality control

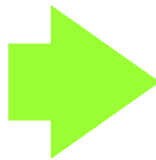


**Bolting occupying
90 % of Engine Assembling**

- **Accurate Torque Measurement** - Producing world best vehicles



Torque standards in KRISS
(0.005 %)



Torque calibration machine
(0.1 %)



Torque wrench
(1 %)

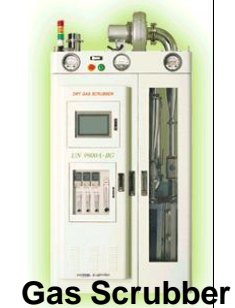
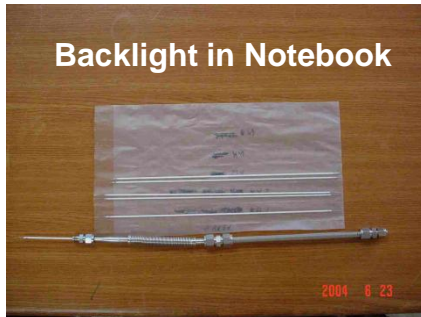


World class car

- Improving Torque Measuring Capability of KRISS: 0.1 % ('99) \Rightarrow 0.005 % ('06)
- Reducing Failure Rate due to Torque Measurement at HYUNDAI: 35.1 % ('99) \Rightarrow 0.5 % ('06)

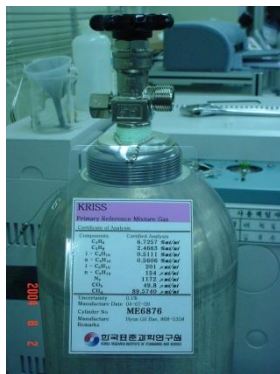
For HYUNDAI Motors

- **Standard Gas for Gas Analysis in Semiconductor & Display industry**



- Gas Analysis : Quality control of products, development of new product & problem solving in process

- **CRMs for Analyzing Natural Gas Analysis, Green House Gas, Air Pollution**



Prices of natural gases depend on concentrations of components (hydrocarbon)

Standards gas for GHG

Analyzing vehicle gas emission

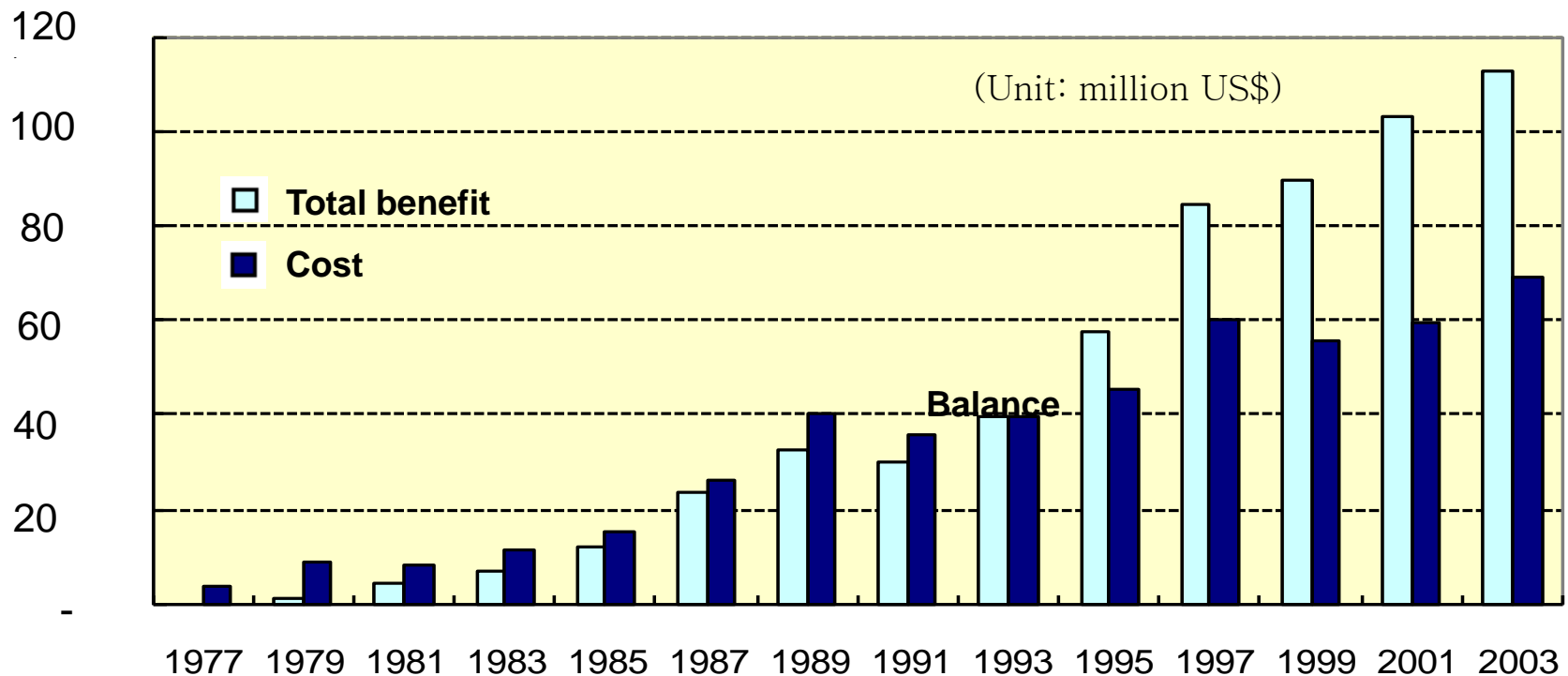
KRISS Contribution to National Economy KRISS

❑ **Direct Value created** : US\$ 860 mil (for 10 years of 1994-2003), **BCR of 1.5**

(Data : Revenue from calibration/testing and CRM services for 10 years: 1994-2003)

❑ **Economic Impact** : US\$ 812 mil, **BCR of 12.76** (FY 2003 budget of \$ 63.7 mil)

❑ Data prepared/analyzed : Bearing Point, Inc. (Jul. 2004)



• **BCR: benefit to cost ratio**

DSME, Korea – BP, USA [2002]

- **DSME: Daewoo Shipbuilding & Marine Engineering**
- **BP: British Petroleum**

Claim

- Offshore plant order by BP, USA.
- **Calibration traceable to NIST required.**

Solution

- DSME, accredited by KOLAS, a member of ILAC MRA.
- DSME, keeping traceability of its standards to KRISs.
- KRISs and NIST are all signatory to the CIPM MRA.
- NIST confirmed that **“traceability to KRISs is equivalent to traceability to NIST”** via the CIPM MRA.
- **BP accepted** accreditation by KOLAS and calibration certificates issued by KRISs.



< DSME offshore plant >

Benefit

- **Saved 11 Million US\$**
- recalibration at NIST; **US\$ 1 million**
- penalty of 2 month delay; **US\$ 10 million**



POSCO – India, Mexico [2004]

• *POSCO: Pohang Steel and Iron Company*

Claim

- **Mexican** manufacturer of automobile parts demanded the proof of reliability of POSCO steel.
- **Indian** buyer of POSCO steel **required the certification from BIS (Bureau of India Standard).**

Solution

- POSCO's testing laboratory, accredited by KOLAS.
- KOLAS is a member of APLAC, and ILAC MRA.
- **POSCO has a traceability to KRISS participating in the CIPM MRA.**
- POSCO's steel accepted without being retested.

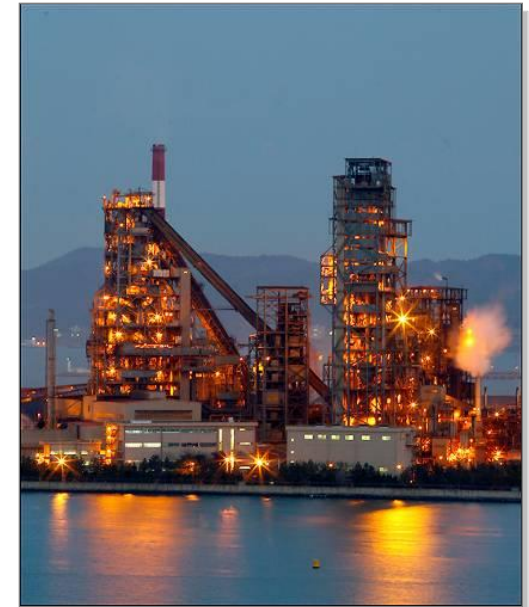
Benefit

- **Saved 5 Million US\$**

Had it not been for the CIPM MRA, ILAC MRA, ...



- Cost in transportation/retesting at Mexican and Indian lab's
- Cost due to delay in delivery



< POSCO steel plant >

Korean Air - US FAA [2004]

Claim

- According to **US Repair Station Act**, **US FAA required KA to secure calibration certificates traceable to NIST.**

Solution

- KRISs and NIST participate in the **CIPM MRA**;
- **FAA accepted** all the KA measuring instruments **traceable to KRISs as traceable to NIST.**

Benefit

- **Saved 9.4 Million US\$**



< Korean Air >

Had it not been for the CIPM MRA,



- **Suspending services for 3 months** while calibrated at NIST; or
- **Additional cost** to substitute instruments; and to establish a new system with traceability to NIST.

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- 5 **Future Perspectives**
- metrological solutions to national and global issues

Vision
(2020)

World-leading
National Metrology Institute

Strategic
Goals

Securing advanced capability
in measurement standards

Ensuring global excellence in
R&D performance
World Class Laboratories (WCL)

Establishing national
measurement system

Maximizing
customer satisfaction

Core
Values

People
of creativity

Sustaining excellence
in performance

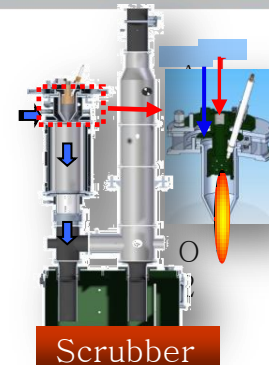
Open collaborative
networks

Customer
values

Government's New Initiatives of S&T National Agenda Projects (NAP)



Measurement technology
to estimate national inventory of GG

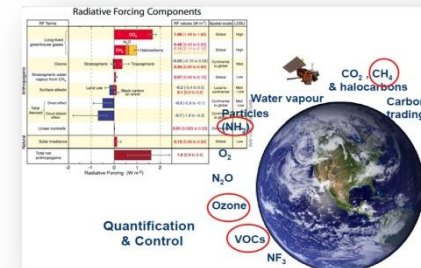


Performance enhancement of
GG reduction system &
Development of
evaluation technology

Standardization of
GG emission amount

KRISs
Leading Institute

Development of GG tracing &
monitoring technology



Enhancing reliability of national total emission inventory of GG,
prerequisite to establish the national policy for solving climatic change

⌘ GG : Greenhouse Gases

❖ Development of SI Traceability for Solar Cell Metrology



Solar Energy Conversion Efficiency

- Radiometric Standard
- Solar Simulator
- Primary Reference Solar Cell

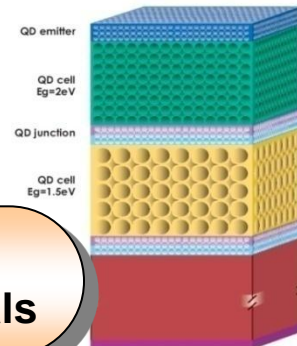
Reliability & Performance of Solar Cell

Measurements in Solar Cell Processes

- Surface Chemical Analysis
- ISO Standard
- CRM & Key Comparison

Characterization of New Solar Cell Materials

- Silicon Nano Structure
- Chemical Compounds
- Organic and Bio Molecules



Leading the Development of Next-Generation Solar Cell

❖ Brain and Cognition Measurement Lab: first KRISS WCL

Technical capabilities

- High-sensitivity SQUID sensor technology
- Measurement technology of MEG & MCG
- Ultra low field-NMR/MRI techniques based on high-sensitivity SQUIDs

Technical targets

- A new modality for measuring brain function
- From laboratory to clinical applications
- Applications: Medical & Chemical analysis

※ SQUID : Superconducting QUantum Interference Device



MEG System
(MEG: MagnetoEncephaloGraphy)

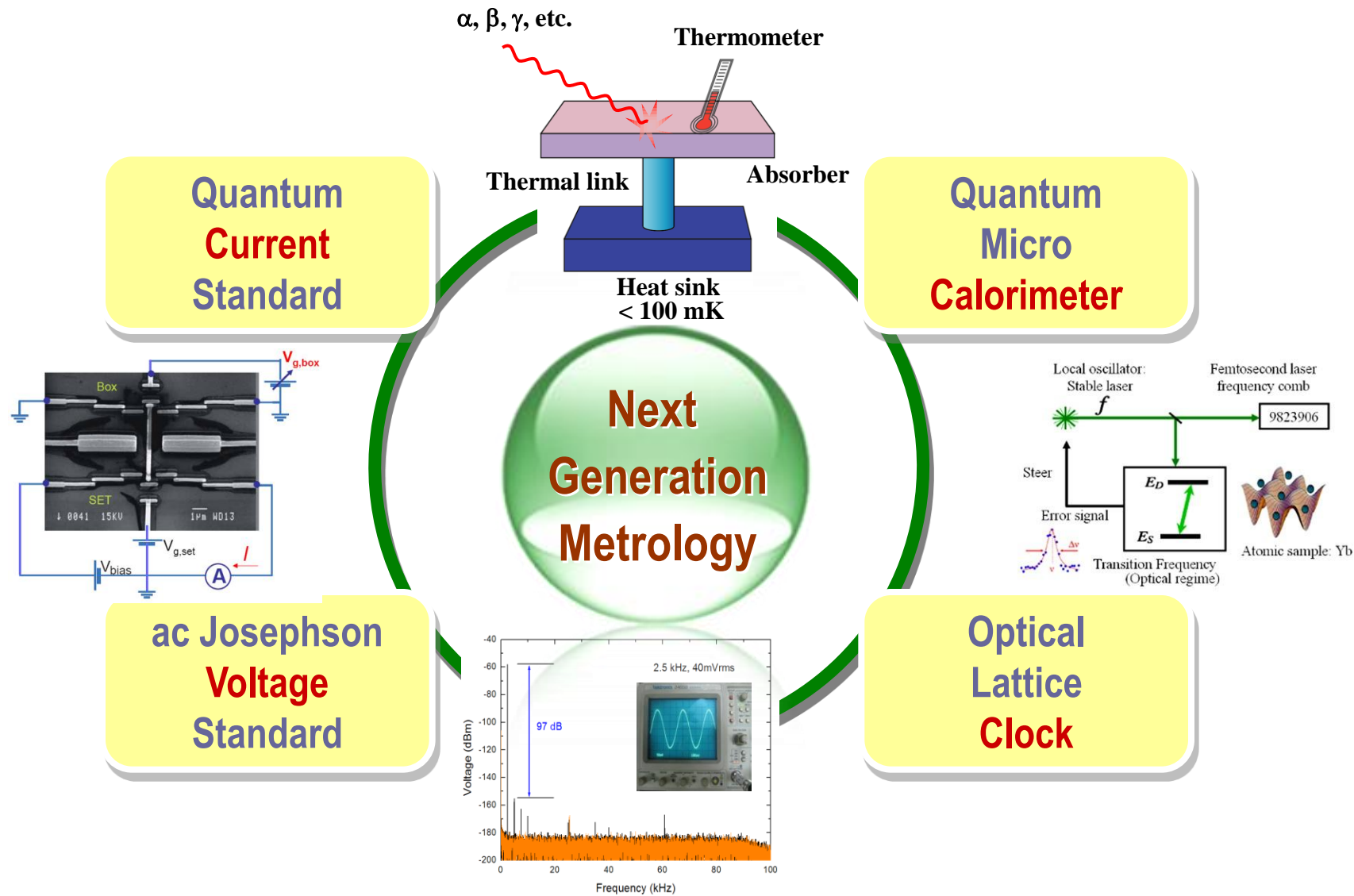
MEG
Supplied to Univ. hospitals
in Korea (Yonsei Univ.)
& abroad (Taiwan Univ.)

MCG
Technology licensing
to a German company
(BMP GmbH)
(Initial royalty of US\$1.5 Million)



Signing of MCG licensing (Aug 9, 2010)
(MCG: MagnetoCardioGraphy)

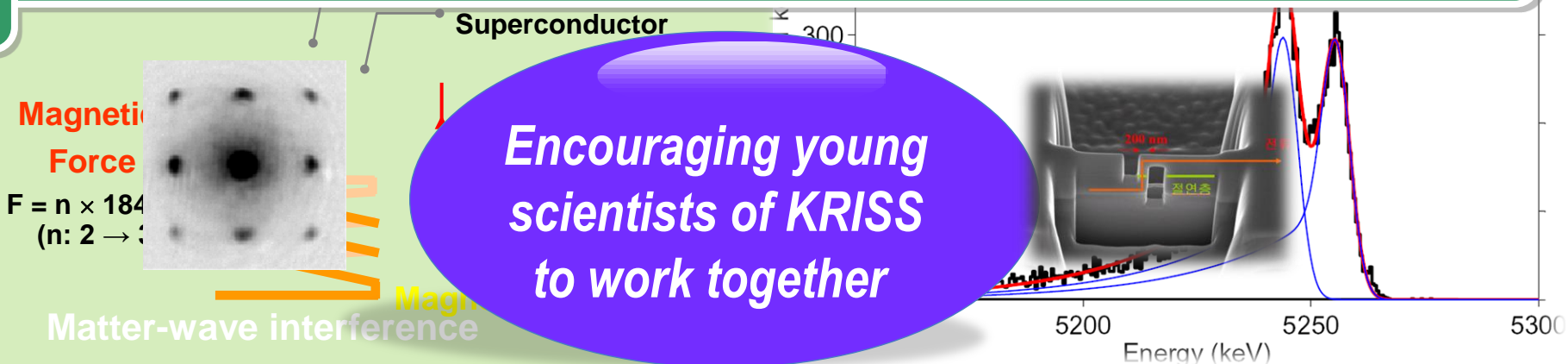
Next Generation Metrology: Quantum-based KRISs



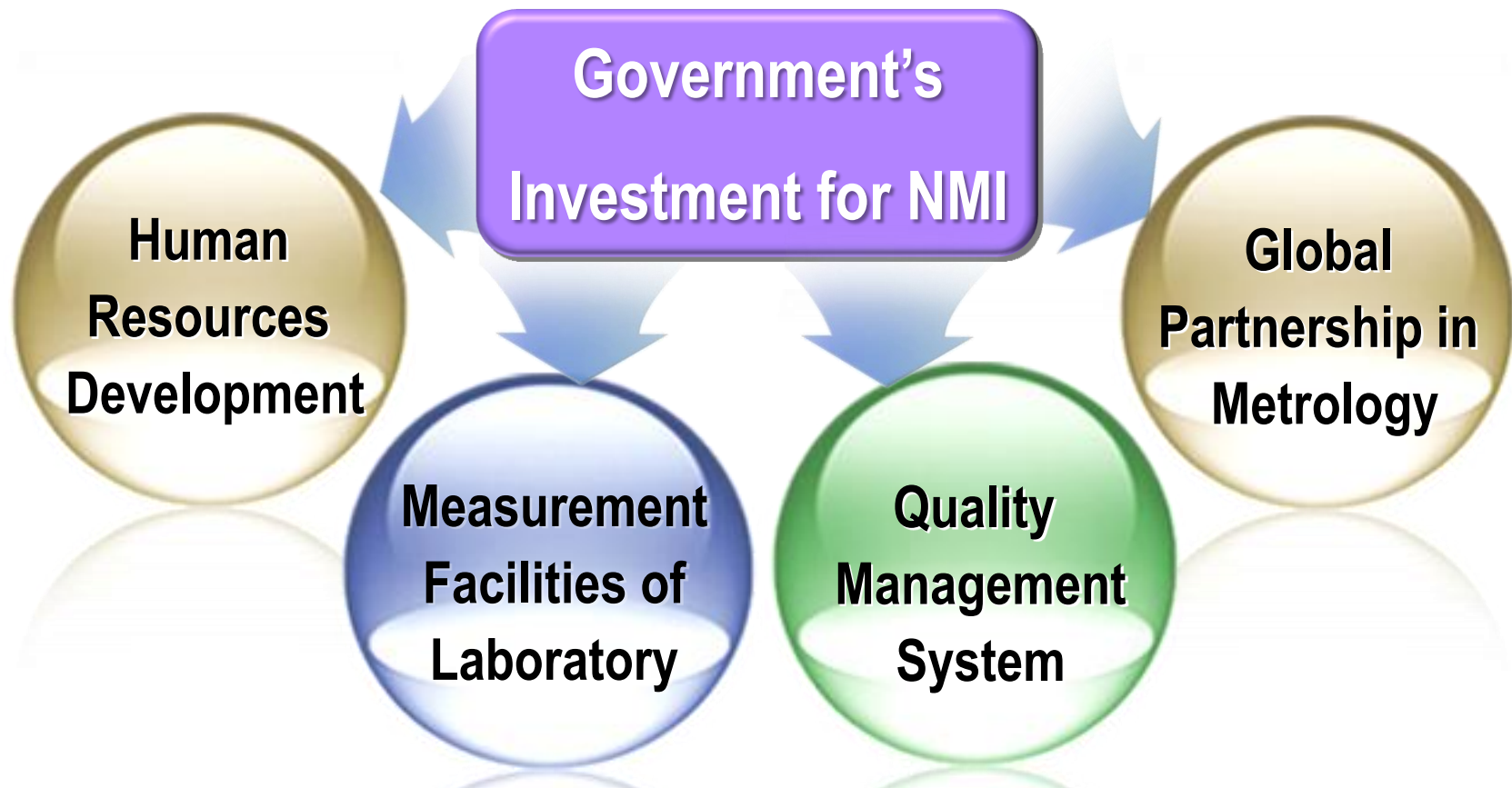
*In pursuit of
novel measurement technologies
leading to new definitions/new principles*

*Focused on subjects of **high risk** but
high potential of strong impact
and **global leadership in R&D***

- Single-quantum-based pico-Newton force standard → **force**
- Shot noise thermometry using nanoscale devices → **temperature**
- Measurement technology for cognitive process → **ultra low field NMR**
- Nanoscale energy conversion → **advanced SThEM**
- ... (scanning thermal/thermoelectric microscopy)



*Encouraging young
scientists of KRISS
to work together*



Lessons learned

- **Investment in metrology** accelerates yield improvement at every stage of manufacturing
- **International collaborations** in metrology enable all partners to share fruits of shared efforts



2002
FIFA WORLD CUP
KOREA JAPAN

Dreams
Come
True!

