Mission and Strategy of NMIJ/AIST, and Economic Impact Analysis of Metrology Standard

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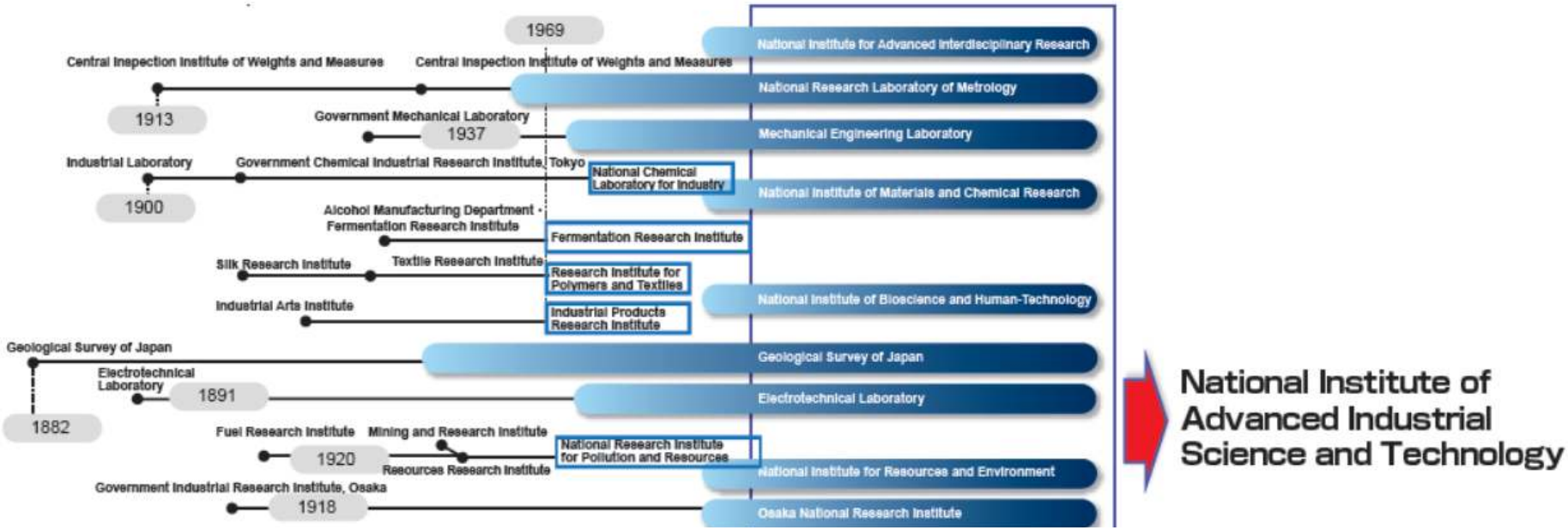
NMIJ/Japan
CIPM Member

CENAM
CENTRO NACIONAL DE METROLOGÍA

NMIJ

At a glance of
National Institute of Advanced Industrial Science and Technology

At a glance: History of the AIST



The AIST was reorganized in 2001 as an autonomous administrative agency upon the integration of the former 15 national research institutes including former national research laboratory of metrology which maintained most of physical measurement standards.

At a glance of AIST: Staff and organization

Staffs

●Researchers (foreign nationals)	2,331 (139)
[Permanent]	[1,982]
[Fixed term]	[349]
●Administrative employees	699
Total number of employees	3,030

Number of researchers accepted through industry/academia/government partnerships

●Companies	1,867
●Universities	2,446
●Public organizations	1,043

(Foreign nationals : 530)

(Total number of researchers accepted in FY 2017)

R&D in 7 categories

- Energy and Environment
- Life Science and Biotechnology
- Information Technology and Human Factors
- Materials and Chemistry
- Electronics and Manufacturing
- Geological Survey of Japan
- National Metrology Institute of Japan

At a glance of AIST: Research bases

- AIST Hokkaido
- AIST Tohoku
- AIST Shikoku
- Fukushima Renewable Energy Institute, AIST (FREA)

- AIST Chugoku
- AIST Tsukuba Headquarters
  - AIST Tsukuba

- AIST Chubu
- AIST Kansai
- AIST Tokyo Headquarters
- AIST Tokyo Waterfront

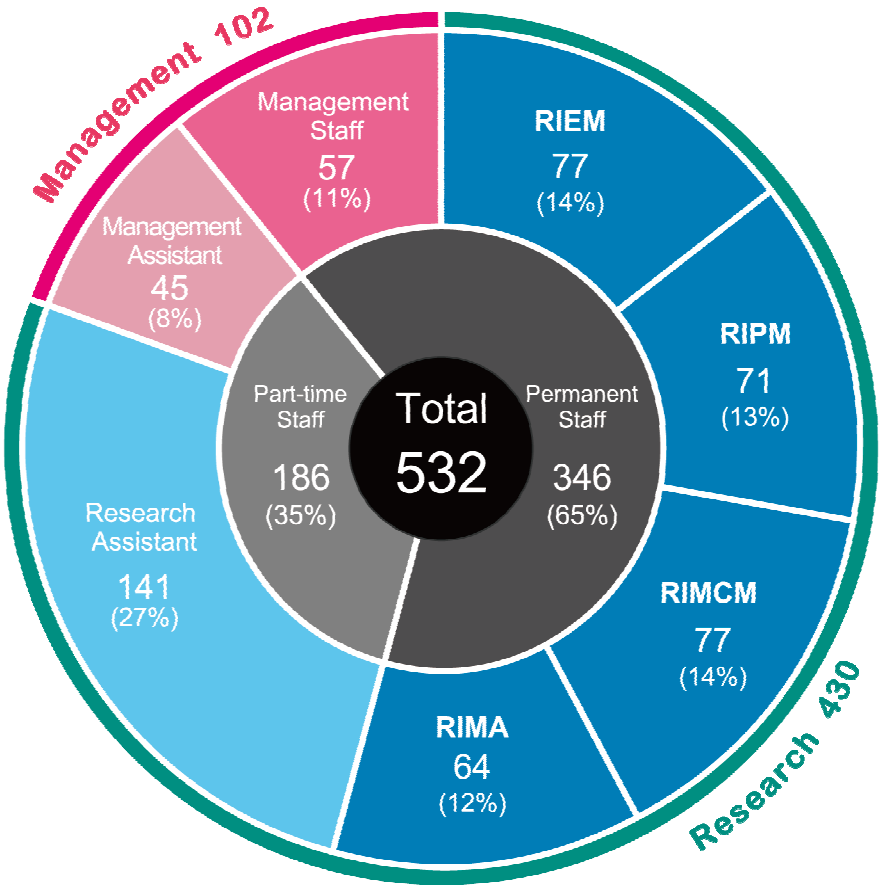
Organization Structure of NMIJ (since April 2017)

- National Metrology Institute of Japan
  - Research Planning Office of NMIJ
  - Mechanical Measurement(RIEM)
  - Physical Measurement (RIPM)
  - Material and Chemical Measurement (RIMCM)
  - Measurement and Analytical Instrumentation (RIMA)
  - Center for Quality Management of Metrology

[Director]
Takashi Usuda

NMIJ Headquarter

At a glance of NMIJ: Personnel (as of 2018)



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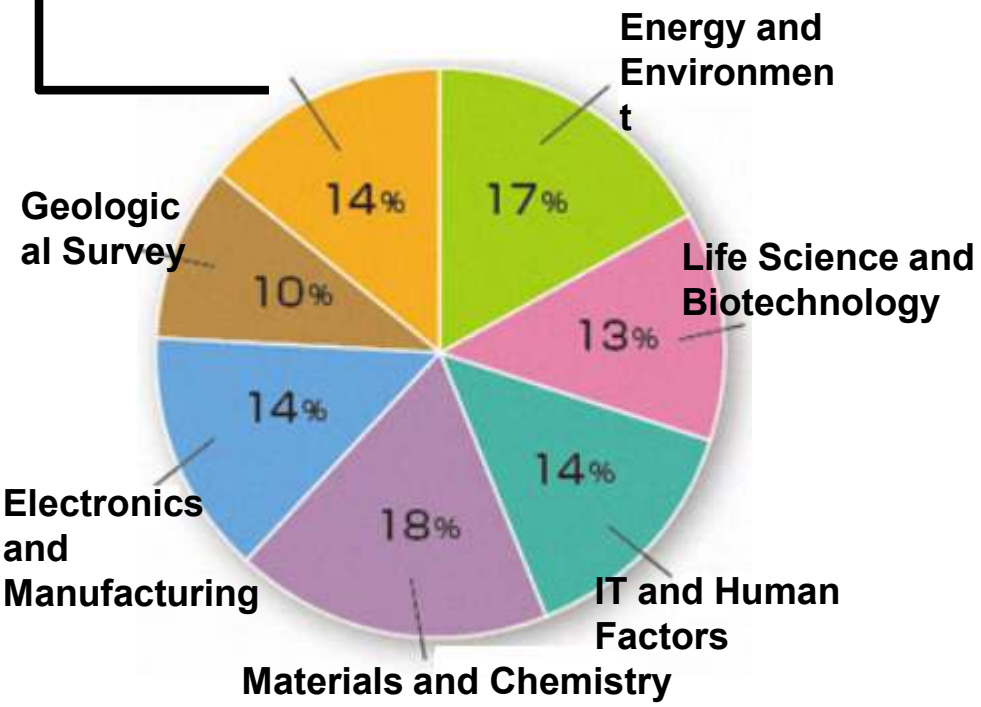
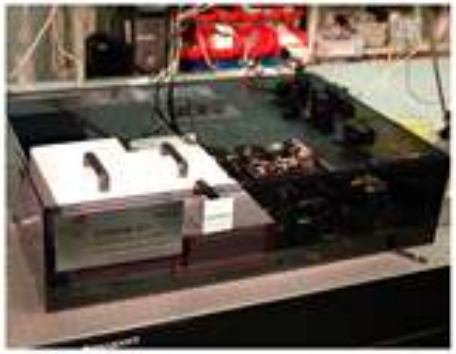


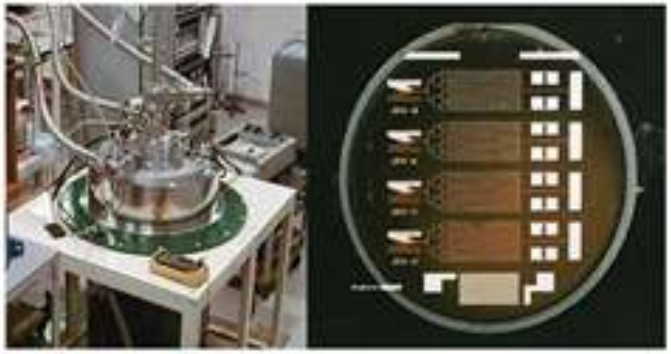
At a glance of NMIJ: It's mission

Length (m)



Optical frequency comb

Electric Current (A)



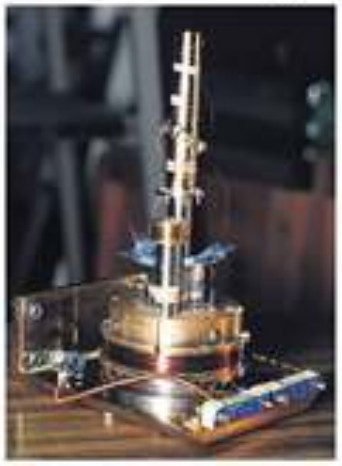
Quantum Hall Resistance system (R)

Josephson effect Voltage standards (V)

Amount of Substance (mol)

Certified Reference Materials

Luminous intensity (cd)



Receiver unit of Cryogenic electrical substitution radiometer

Mass (kg)

Kilogram prototype

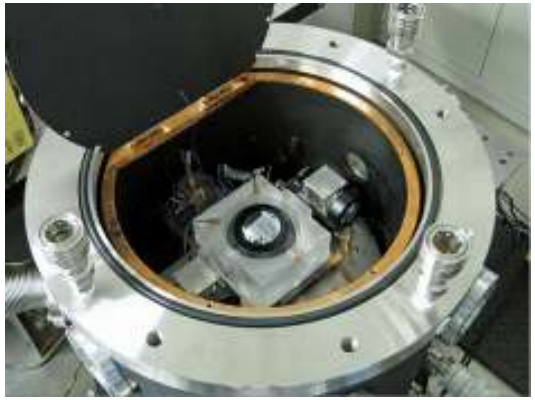
Time (s)

Cesium atomic fountain frequency Standard

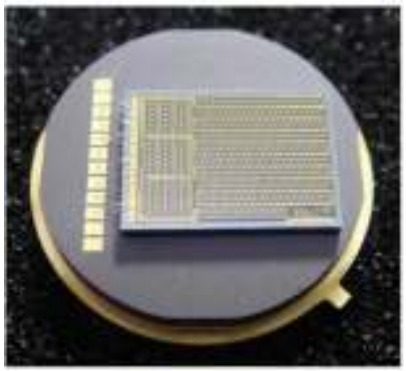
Thermodynamic temperature (K)

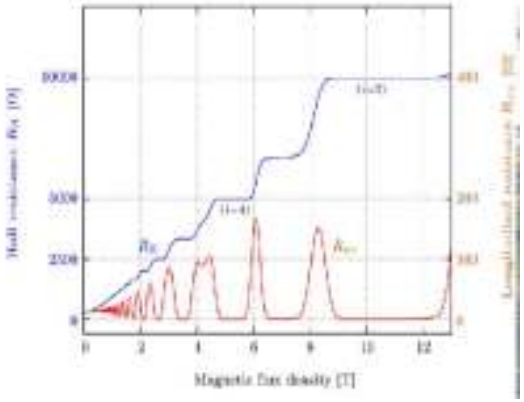
Water triple-point cell

At a glance of NMIJ: Scientific activities

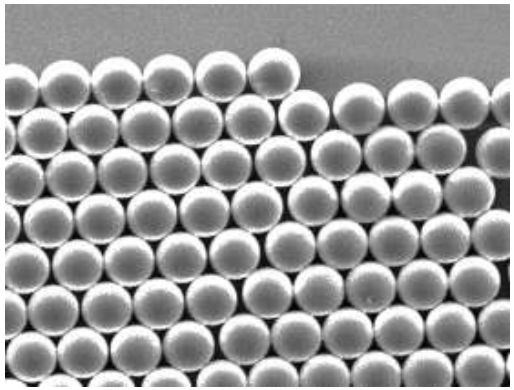


Redefine kg by Silicon route





Integrated quantum Hall effect device



Particle analysis and SRM

Microscopic analysis by positron beam

At a glance of NMIJ: International corporation

MoU with CENAM on technical development and other bilateral and multilateral corporations

AIST, as an autonomous agency

Engage in a mid-term plan revised normally once every 5 years based on the contract with the government

Period	2001-2004	2004-2009	2010-2014	2015-2019
Main issue of AIST	Formulate new research organization	Establish transparent R&D strategy	Open platform, more efficient R&D	Direct commitment to economy
Issues in NMIJ	Establish national primary standards, adopt CIPM-MRA	Establish national primary standards, adopt CIPM-MRA	More efficient dissemination of metrology standard	Direct commitment to economy

During 2015 to 2019, AIST is requested to get a triple of private fund compare the past performance.

NMIJ strategy in the mid-term plan 2015-2019

- Technology transfer (Equipment and instrumentation).
- Measurement to provide solutions in industries.
- Knowledge transfer.
- Technical assessment for validation and standardization.

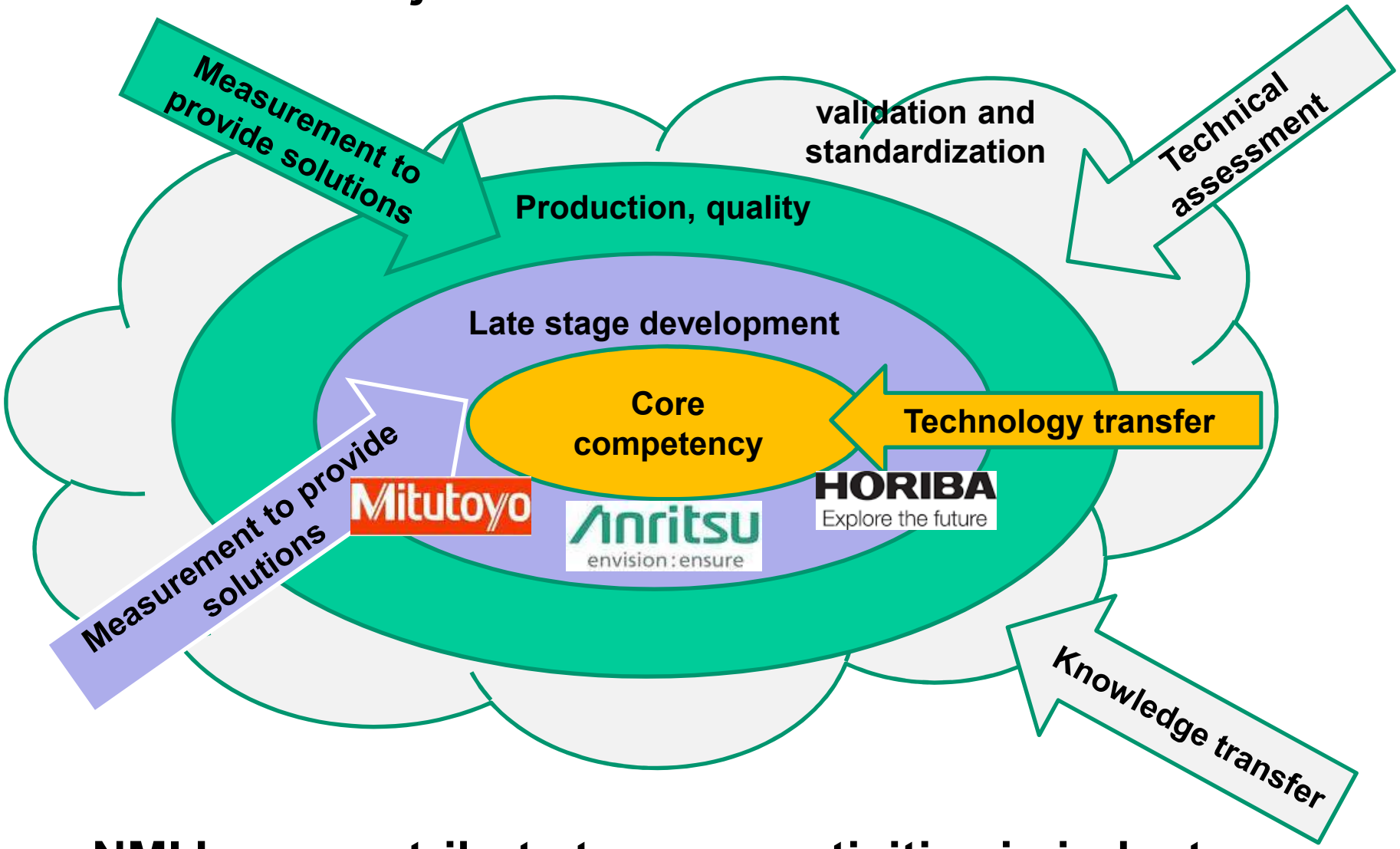
Who is our customer?

Mitutoyo

Anritsu envision : ensure

HORIBA Explore the future

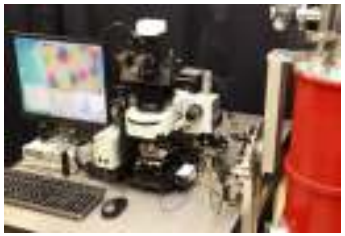
Major customer of NMIJ



NMIJ can contribute to every activities in industry

Quantization

Photon detection



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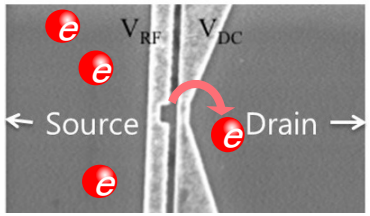
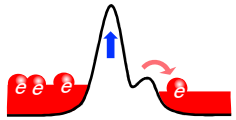
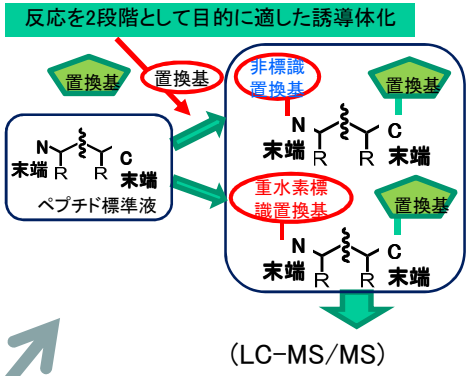




Scalable measurement

Protein measurement



Moire

Core competence

Measurement calibration

Transparent (See through)

X lay measurement

Tunnel inspection

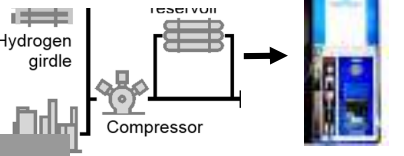
Non destructive testing

3D Xlay CT

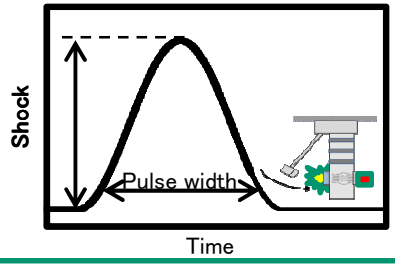
EMC by Rabi oscillation

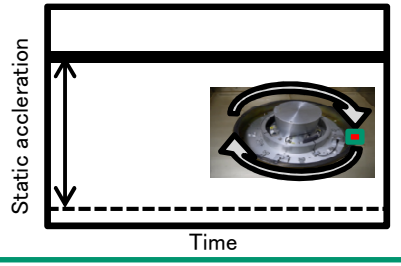
Validation and conformity assessment

H2 fuel cell



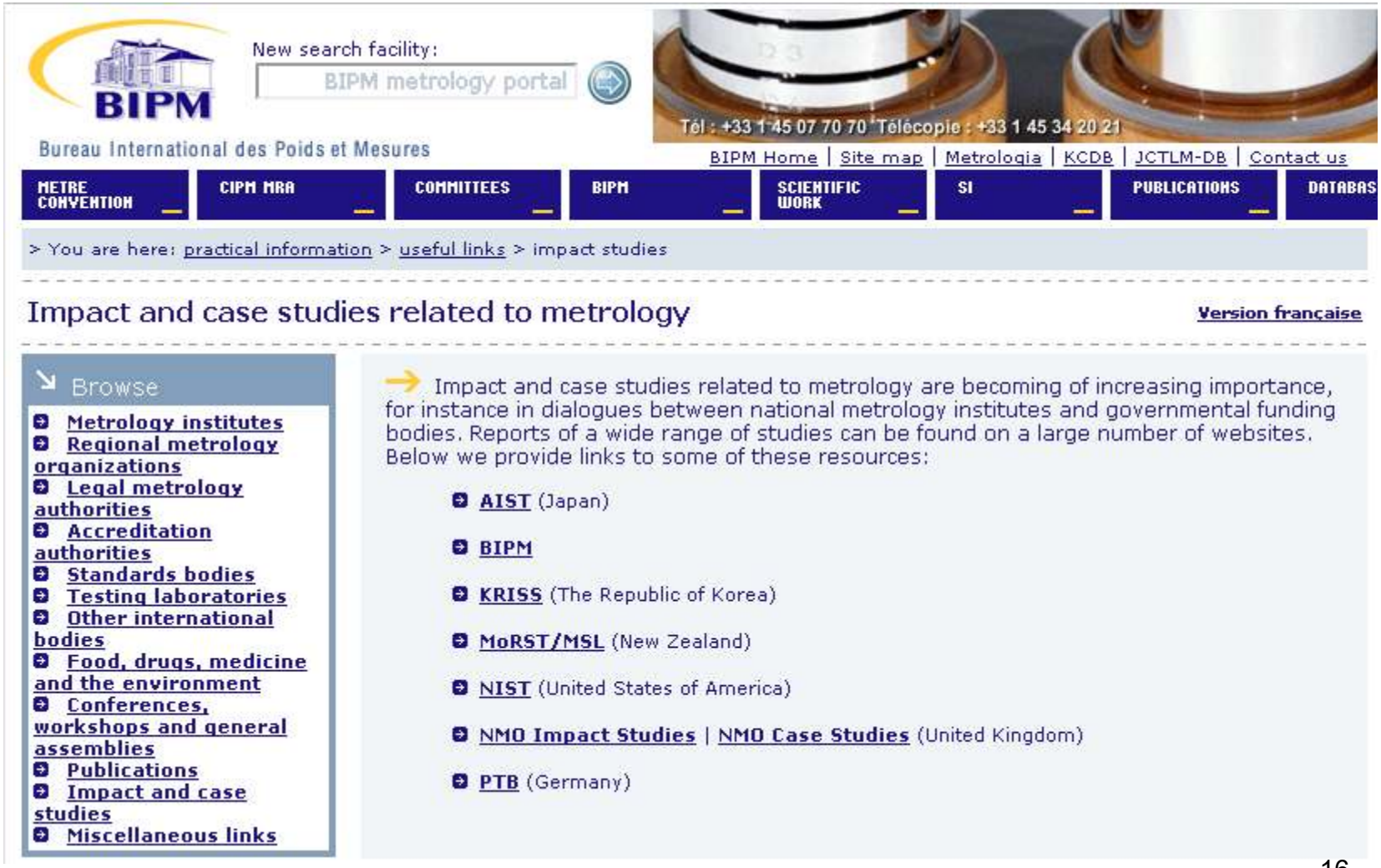
Shock measurement





- So far NMIJ found that our technical competency (not only the primary metrology standards but also our deep understanding in measurement, testing, uncertainty analysis, and standard conformity assessment) are highly appreciated by private sectors.
- During the first 3 years of the period, NMIJ got a triple of private funds from industries (we completed mid-term 5 year target within 3 years!). This is the most successful one among the 7 research area in AIST.
- NMIJ is also requested to maintain national primary standards as a public institute, which costs can not fully covered by the revenue from private sectors.
- We need to justify the public cost for maintaining metrology standard, HOW?

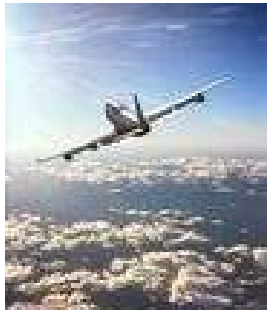
Links to the past studies on the BIPM website



The cost of technical barriers to trade

- **lack of compliance with standards reduces trade:**
  - **developed** and G22 countries lose between 1% and 15%
  - developing and LDCs lose between 10% and 40%.
- 70% of the burden on developing countries' manufactured exports comes from trade barriers erected by other countries
- The EU single market reduced trade costs of the pre-expansion EU by 2.5% by using "harmonised" standards
- New Zealand exporters pay 5% to 8% of exports to overcome TBTs

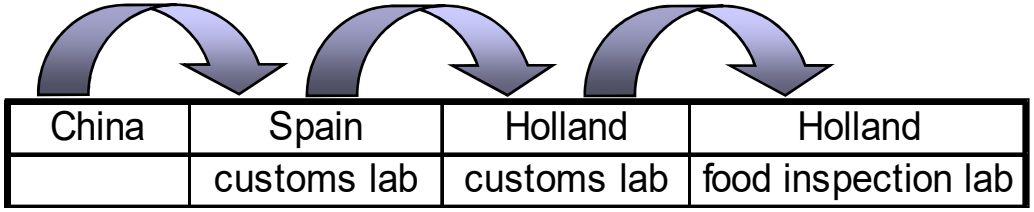




From presentation by Dr. Martin Milton

An example – frozen shrimps from China to Europe

Limit on antibiotic residues (chloramphenicol) in frozen shrimps set by EU2377/90 at "zero"



- **11 containers of frozen shrimps valued at $1.1M destroyed**
- **EU recognised the problem of specifying "zero" and developed the concept of Minimum Required Performance Limits for detection of substances**
- **Measurements can help reduce barriers to trade.**

From presentation by Dr. Martin Milton

An example – trade from India to Mexico in 2004

Pohang Steel and Iron Company (POSCO)

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 had been accredited by KOLAS.
- KOLAS is a member of APLAC and signatory to the ILAC MRA.
- **POSCO has a traceability to KRISS participating in the CIPM MRA**.
- POSCO's steel accepted without being retested in India and Mexico.

Benefit

- **US$ 5 million saved**
- US$ 70 000 Invested for calibration

From presentation by Dr. Martin Milton

New approach for estimating the economic impact

Modeling

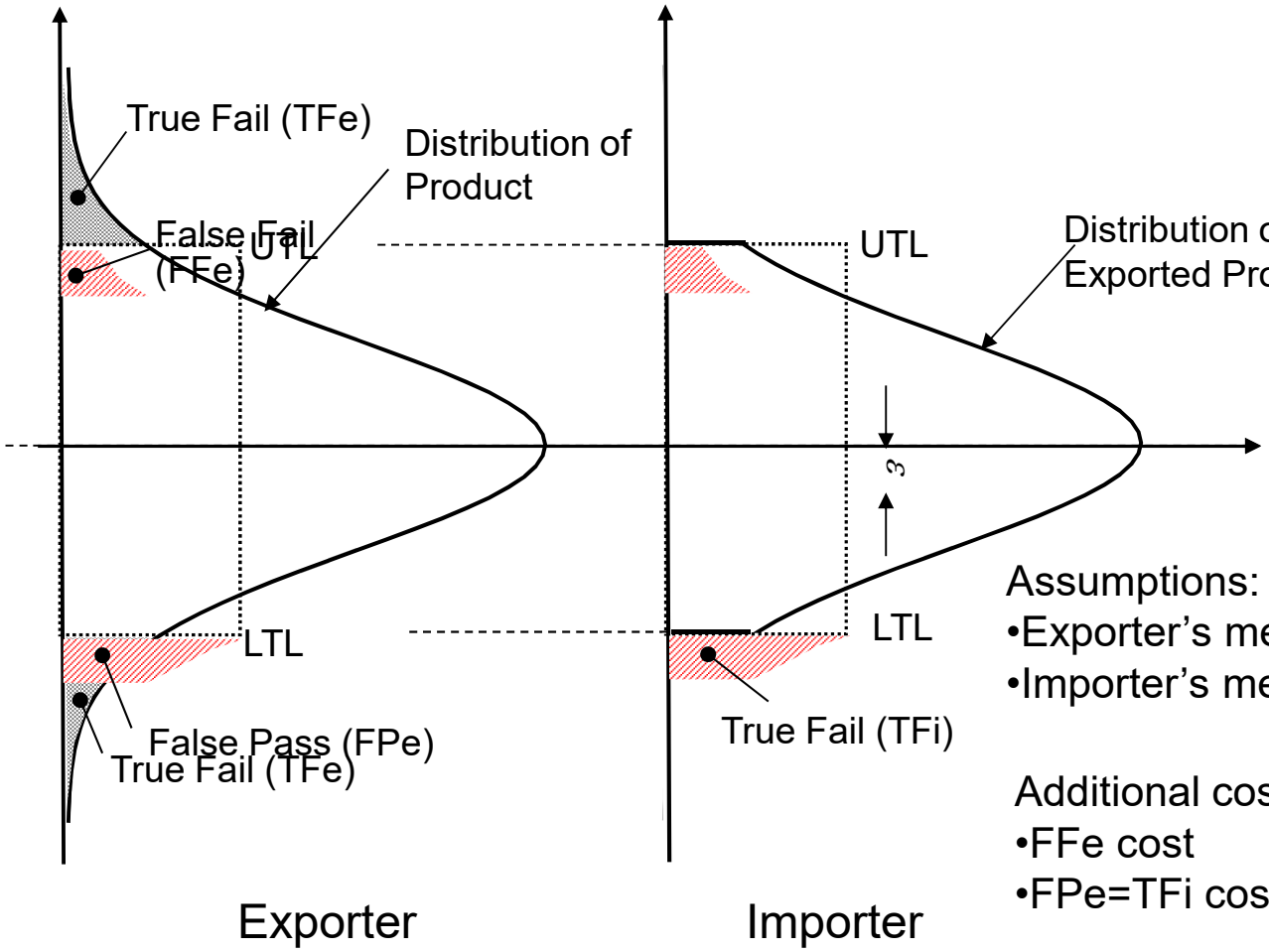
•To simplify, two concerned relationship (exporter and importer) is picked up

•If there is deviation between metrology standards of the exporter's and importer's, there must be additional cost associated.

•Associated cost may be categorized for False Fail and False Pass

•Economical impact can be assumed those additional cost

Effect by the Deviation between Importer and Exporter



Assumptions:
- Exporter's measurement has deviation ε
- Importer's measurement is correct

Additional cost associated:
- FFe cost
- FPe=TFi cost -> much heavier damage

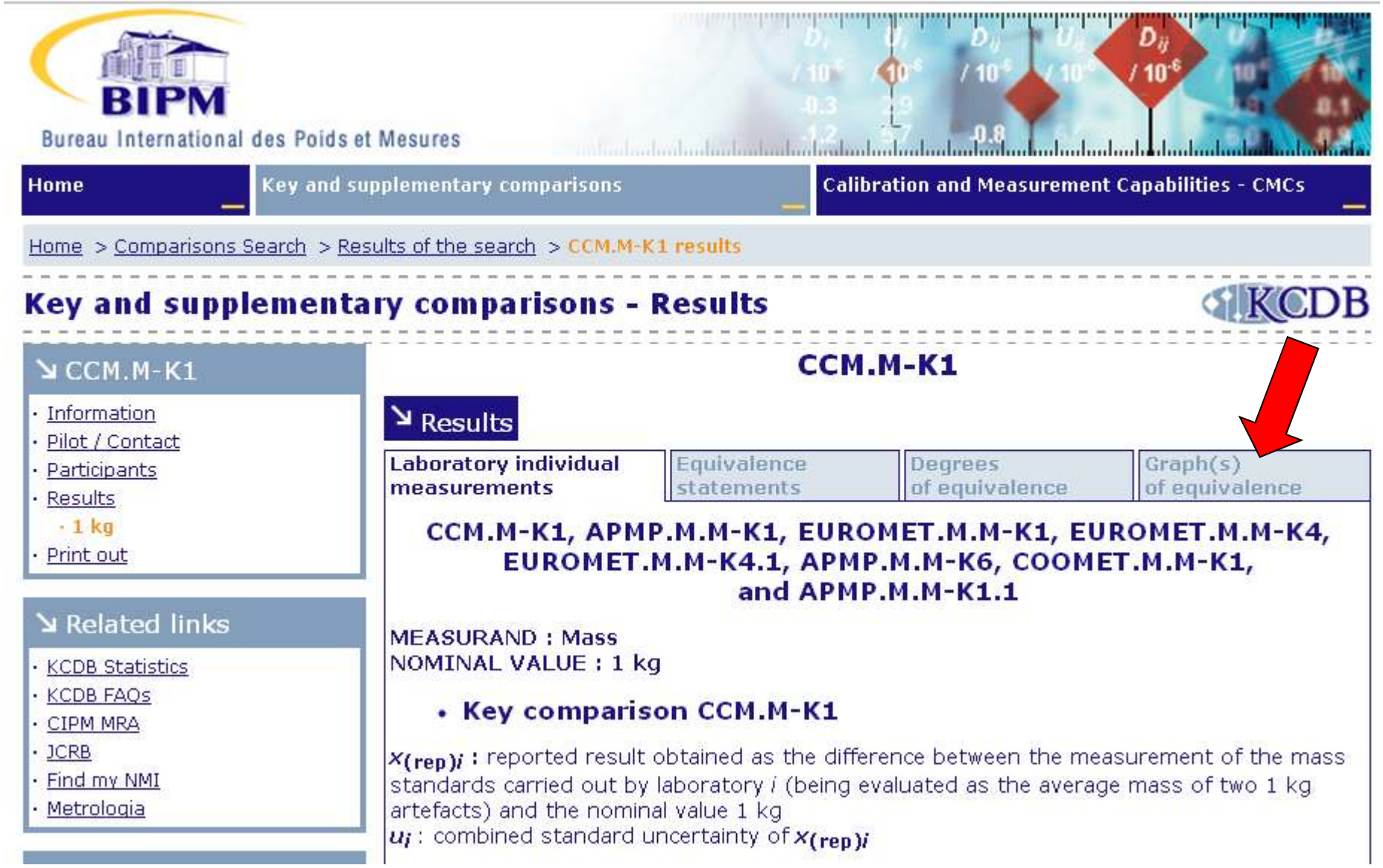
Economical Impact: FFe+FPe

New approach for estimating the economic impact

For further investigations, what we need is…

- Distribution of the product associated with measurand (quality)
  - **Which is usually confidential parameter**
- Deviation of measurement standard ε, fact or assumption
  - **Which is obtained from KCDB**
- Associated costs may be calculable statistically.

KCDB (Key comparison database)



BIPM
Bureau International des Poids et Mesures

Home | Key and supplementary comparisons | Calibration and Measurement Capabilities - CMCs

Home > Comparisons Search > Results of the search > CCM.M-K1 results

Key and supplementary comparisons - Results

KCDB

↘ CCM.M-K1
- Information
- Pilot / Contact
- Participants
- Results
  - 1 kg
- Print out

↘ Related links
- KCDB Statistics
- KCDB FAQs
- CIPM MRA
- JCRB
- Find my NMI
- Metrologia

CCM.M-K1

↘ Results

Laboratory individual measurements | Equivalence statements | Degrees of equivalence | Graph(s) of equivalence

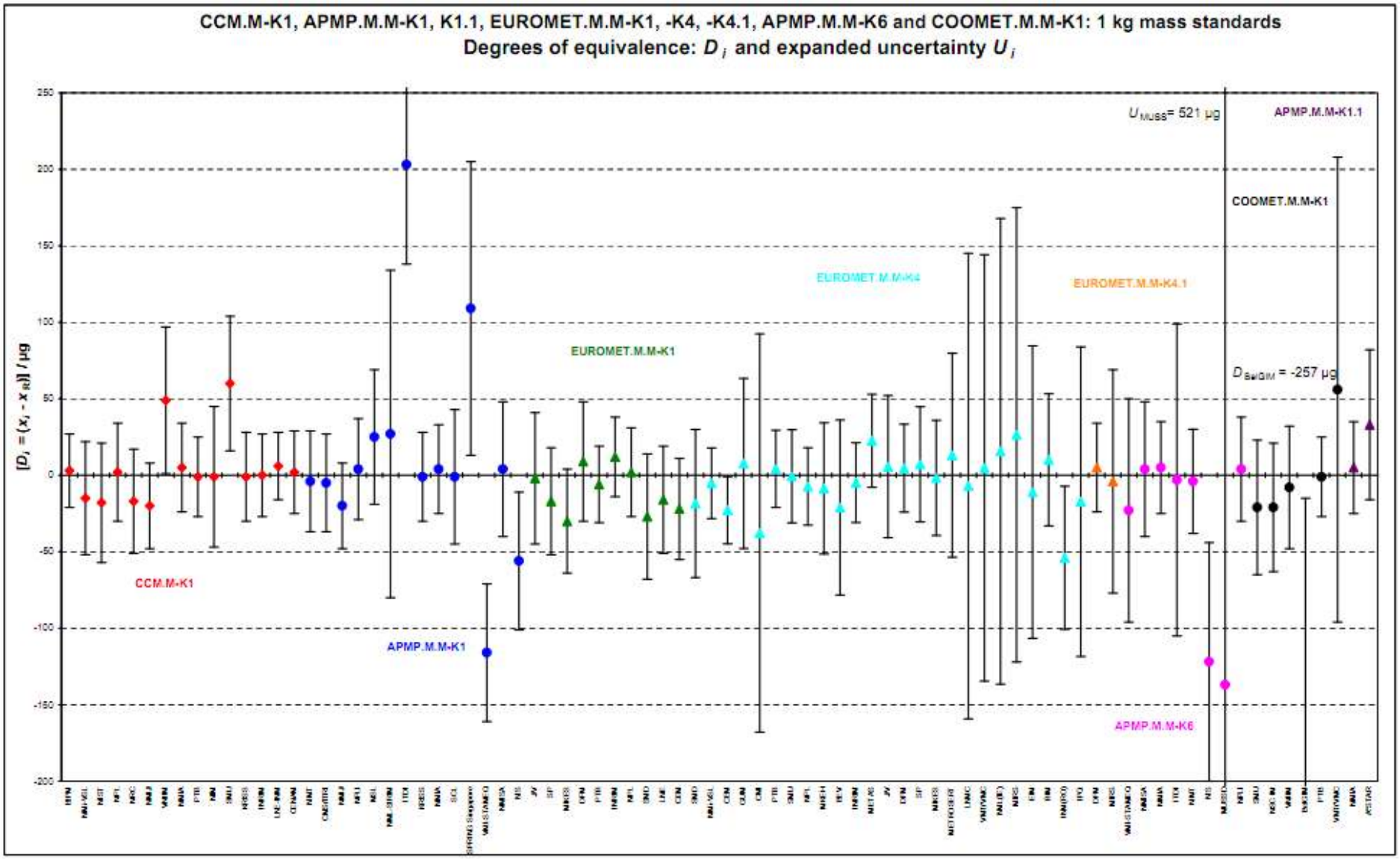
CCM.M-K1, APMP.M.M-K1, EUROMET.M.M-K1, EUROMET.M.M-K4, EUROMET.M.M-K4.1, APMP.M.M-K6, COOMET.M.M-K1, and APMP.M.M-K1.1

MEASURAND : Mass
NOMINAL VALUE : 1 kg

- **Key comparison CCM.M-K1**

$x_{(rep)i}$: reported result obtained as the difference between the measurement of the mass standards carried out by laboratory *i* (being evaluated as the average mass of two 1 kg artefacts) and the nominal value 1 kg
u_i : combined standard uncertainty of $x_{(rep)i}$

KCDB (Key comparison database)



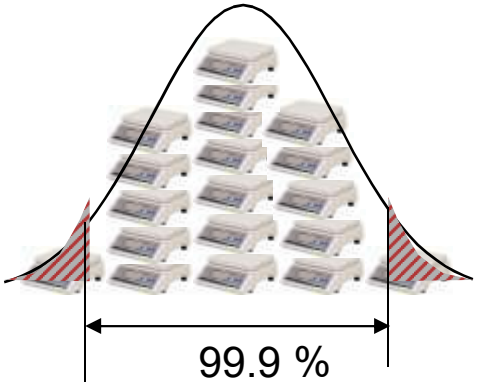
Empirical investigation on Japanese automated balance

Following assumptions and interviews were employed for case study in Japanese automated balance provider

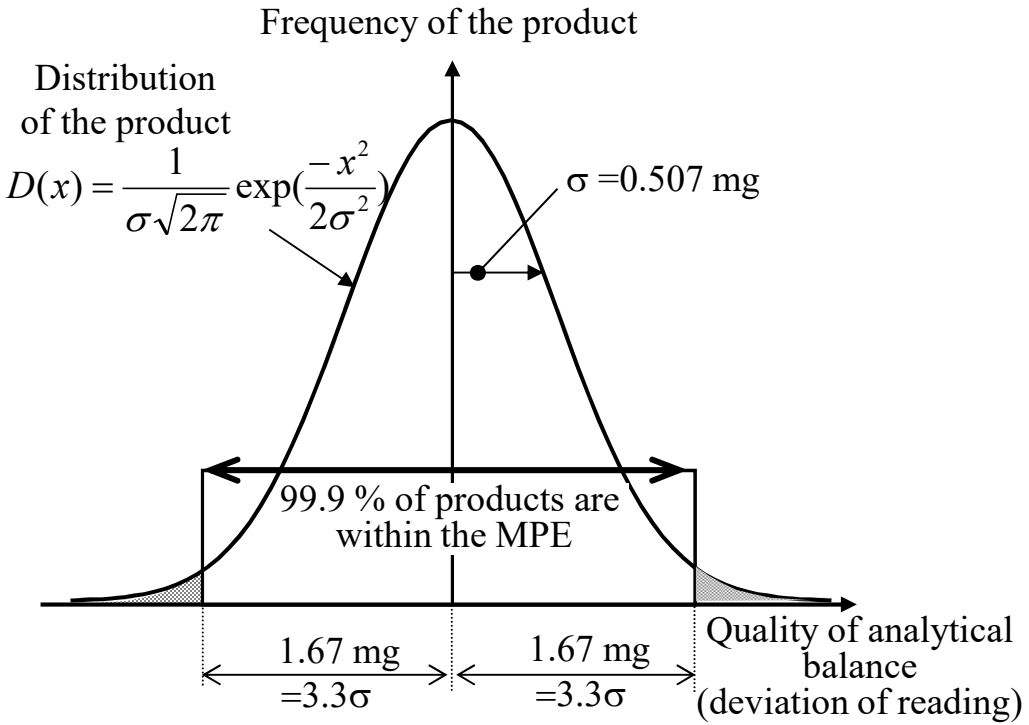
As they do
- All products are tested (not sample test).
- Test failed product is rejected.

Interviewed parameters to Japanese precision balance provider and their answer
- LTL, UTL (correspond to the specification of the balance, equivalent to OIML F1 class)
- Present rejection rate. This will derive product distribution (with assumption of normal distribution)

Automated balance production and inspection



99.9 % of products satisfy the regulation (OIML requirements: 1/3 of Class F1 tolerance = +/- 5 mg at 1 kg)



If Japanese metrology standard shifts ε, associated failures are expressed

- False Fail (FFe)

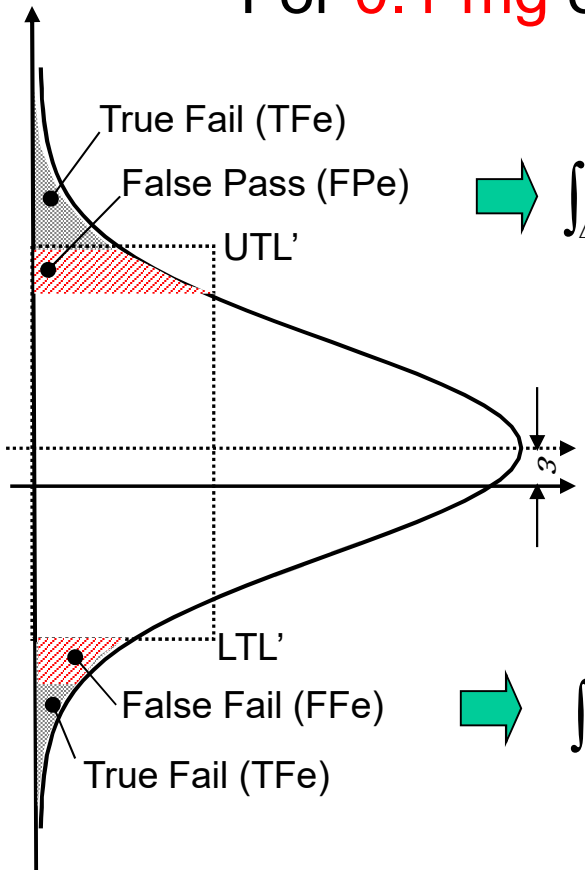
$$\int_{-\Delta}^{-\Delta+\varepsilon}\frac{1}{\sigma\sqrt{2\pi}}\exp(\frac{-x^2}{2\sigma^2})dx$$

- False True (FTe)

$$\int_{\Delta}^{\Delta+\varepsilon}\frac{1}{\sigma\sqrt{2\pi}}\exp(\frac{-x^2}{2\sigma^2})dx$$

Simulation of the impacts

For 0.1 mg of ε shift corresponds,



$$\int_{\Delta}^{\Delta+\varepsilon} \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-x^2}{2\sigma^2}\right) dx$$

0.048 % of product

$$\int_{-\Delta}^{-\Delta+\varepsilon} \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-x^2}{2\sigma^2}\right) dx$$

0.025 % of product

Causes compensation cost
More serious

Causes proportional cost

Total export turnout of automated balance of Japan: 140M Euro,
0.1 M Euro economic imapct
(lower bound)

Exporter

Total export turnout of automated balance of Japan: 140M Euro (2009)*
Source from Japan Measurement Instruments Federation

Simulation of the impacts

For x mg at 1 kg of ε shift corresponds,

ε	FP %	FF %	Total impact
0.5 mg	0.48	1.001	2.1 M Euro
0.1 mg	0.025	0.048	100 K Euro
0.05 mg	0.014	0.02	20 K Euro
0.01 mg	0.0033	0.0036	10 K Euro
2 μg	0.0007	00007	0.4 K Euro

Stability of IPK: 1 kg 50 μg

CCM.M-K1, Mass Standards: 1 kg *u*R = 2.2 μg

* Based on the total export turnout of automated balance of Japan: 140M Euro (2009)
Source from Japan Measurement Instruments Federation
The loss does not include extra cost for compensation, penalty, etc.

Conclusion

We can conclude that the Japanese weighing scale industry can enjoy the current equivalence of mass measurement standards at the cost of some thousand to million Euros. In other words, monetary loss of some tenth K Euros to the Japanese weighing scale industry could be decreased if the equivalence of measurement standard among countries is improved.

Conclusions

- During the 4th mid-term plan period (5 years), NMIJ is expected to perform their capability not only by providing measurement standards, but also by vitalizing industries.
- During the first 3 years of the period, NMIJ got a triple of private funds from industries (we completed mid-term 5 year target within 3 years!).
- NMIJ is also requested to maintain national primary standards as a public institute.
- NMIJ should scrutinize their portfolio, long-term strategy, to perform both keeping national metrology standard and vitalizing industries consistently.
- NMI community should analyze the economic impact by metrology standard because it is not always explicit.

Muchas gracias!
Than you for your attention.