Measurement Standards Laboratory of New Zealand

Strategic Plan

2022 – 2027

The road to protecting Aotearoa New Zealand's future

- underpinning trust
- anchoring the national quality infrastructure
- meeting measurement challenges of the future
- maintaining NZ's international credibility as a trading partner

A business unit of:

CallaghanInnovation
New Zealand's Innovation Agency

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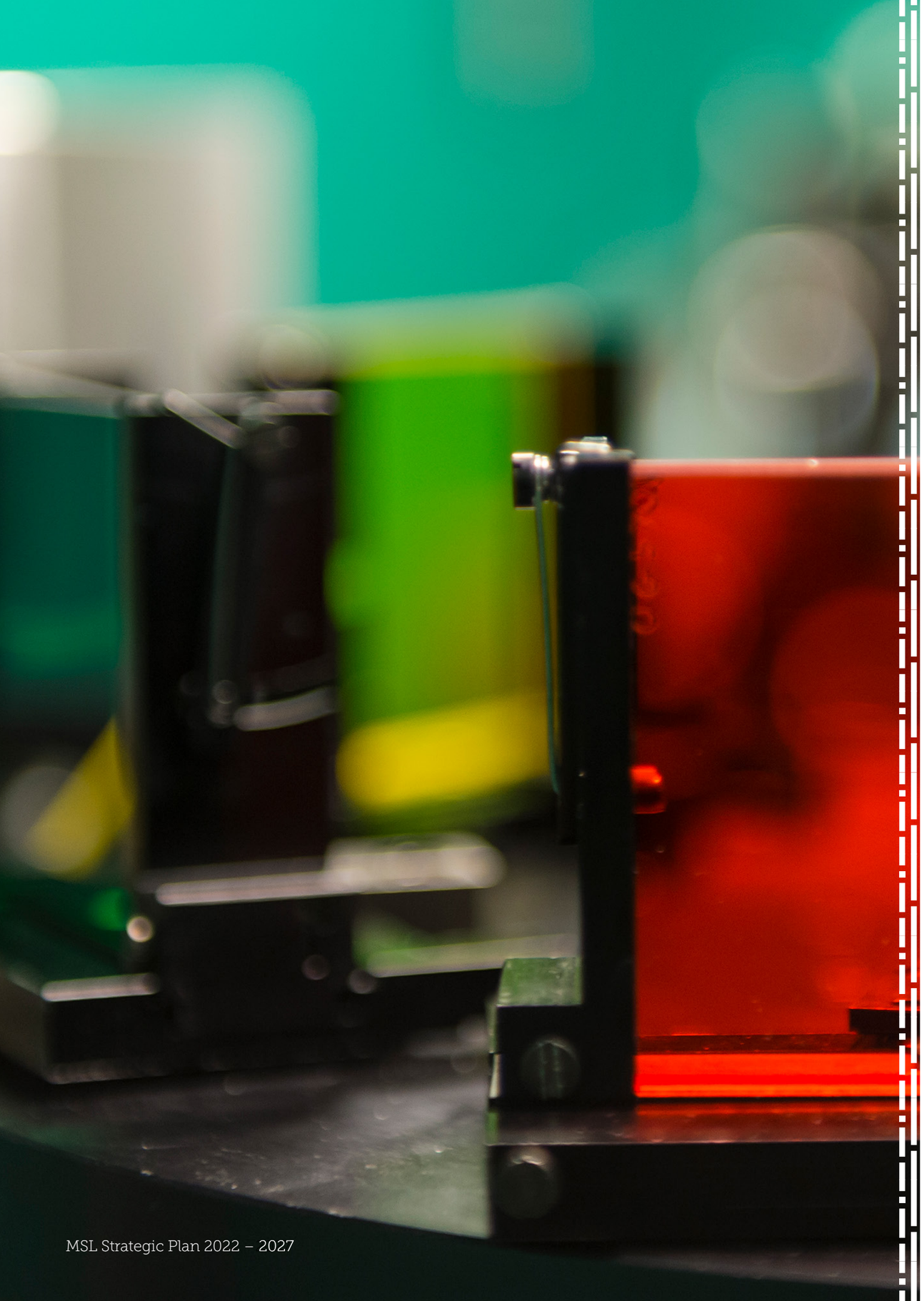

Director's Foreword

When the metric treaty was signed in Paris on 20 May 1875, its purpose was to support trade requiring measurements of length, mass, and volume. The adoption of agreed definitions of the kilogram and the metre on that date laid a platform on which economies around the world have cooperated to build the International System of Units (the SI). This system is the basis of a trusted measurement quality infrastructure that now supports not only trade, but innovation, research, regulation, and wellbeing.

In New Zealand, the Measurement Standards Laboratory (MSL) ensures all New Zealanders have access to world class measurement services that are internationally recognised.

Consequently, we don't have to think twice about the safety of foods we consume from all around the world, or doubt the volume of petrol dispensed at the bowser. Beyond trade and certification, accurate measurements allow us to adopt the technologies that have transformed our lives, and enable us to respond to the challenges of the twenty-first century, including communicable disease, climate change, and environmental sustainability.

MSL provides measurement services to Aotearoa New Zealand to equip it for today and tomorrow. In this strategic plan, we set out how we will respond to the needs of our nation to strengthen its measurement quality infrastructure, support its ambitions to become a technology driven economy, and ensure the health and wellbeing of all New Zealanders.

Annette Koo
Chief Metrologist and Director

Our Goal

Metrology is the science of measurement. As New Zealand's national metrology institute (NMI), our goal is to support New Zealand's economy, wellbeing, and innovation by providing measurement standards and expertise that are globally relevant and trusted.

Our Vision

- New Zealand's measurement infrastructure is nationally and internationally relevant, recognised, and respected.
- MSL ensures measurement, testing, and decision making (based on that measurement infrastructure) meet the needs of government, industry, trading partners, Māori, and the New Zealand public.
- New Zealand's measurement system is founded on science-led systems and standards.

Strategic Context

The Measurement Standards Laboratory of New Zealand (MSL) is New Zealand's national metrology institute (NMI), ensuring New Zealand's units of measurement are consistent with the International System of Units, the SI. MSL is part of Callaghan Innovation, whose mission is to activate innovation and help businesses grow faster for a better New Zealand.

A national metrology (measurement) system is an integral part of the infrastructure required for a well-functioning economy, similar to having legal and currency systems. Accurate, traceable, and reliable measurements allow markets and economies to transact in confidence. Measurements are necessary to support government regulations for health, safety, and the environment, and underpin practically all industrial processes and many innovations.

International Context

The International Committee of Weights & Measures (CIPM) promotes world-wide uniformity in units of measurement. MSL participates on CIPM technical committees, where our knowledge and research expertise is relevant to the maintenance and development of the international units of measurement. Our participation in this international community (via comparisons, peer review, and scientific exchange) gives a technical/defensible basis for our claims and, therefore, for the confidence New Zealand and our trading partners can have in our capability.

Closer to home, MSL is active in the Asia-Pacific Metrology Programme (APMP). The APMP is vital for the recognition of New Zealand's measurement capabilities on the database of Calibration and Measurement Capabilities (CMCs). This list of capabilities is part of the framework created by the CIPM Mutual Recognition Arrangement, signed by all NMI Directors, in which we agree to recognise measurements and their associated accuracies made in signatory countries.

MSL's connections to these international communities ensure:

- New Zealand's interests are represented when decisions are made
- International trends and developments are monitored and responded to
- New Zealand plays its part in contributing to the health of the international quality infrastructure to keep the technical barriers to trade low, support innovation, and share in the response to global challenges.

Legal Context

MSL has the primary responsibility for the provision of physical measurement standards under the following legislative frameworks:

- Measurement Standards Act 1992
- Measurement Standards Regulations 2019
- Weights and Measures Act 1987
- Standards and Accreditation Act 2015
- Fair Trading Act 1986
- Transport Act 1962.

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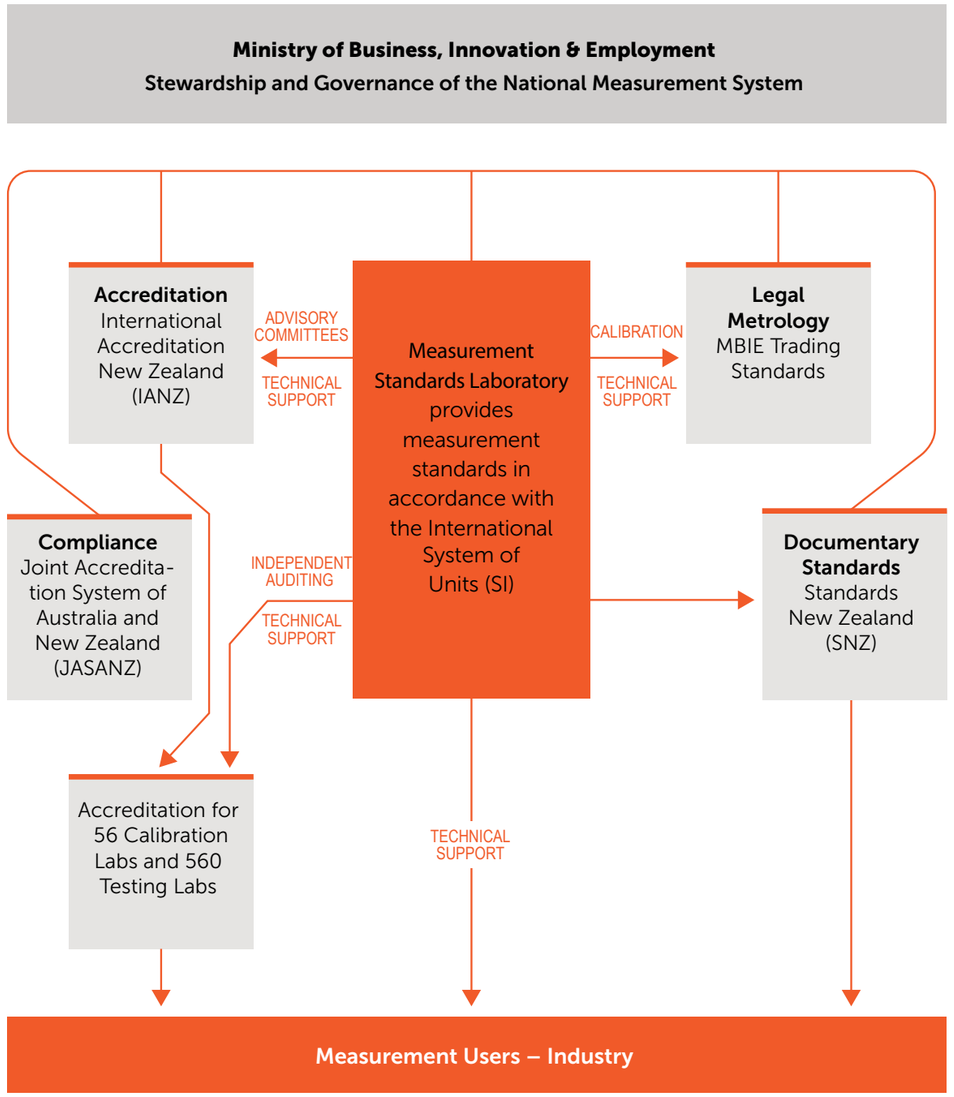


Why We Need a National Metrology Institute

MSL ensures New Zealand has ready access to measurements traceable to recognised international standards. This is essential for New Zealand's ongoing international trade and to serve as a technical basis for solving major scientific, social, regulatory, industrial, and economic challenges.

UV Radiation

MSL provides calibration and advice in the measurement of ultraviolet (UV) radiation. We support industries that use the high energy of UV radiation for sterilisation of surfaces, or non-destructive testing for stress in aircraft components and pipelines. With the same expertise, we also enable monitoring of harmful solar UV, and testing of items such as swimwear and shade cloth to protect from UV radiation.

Measurement underpins scientific and technological innovation, enhances competitiveness in business, and strengthens regulation of health, safety, and the environment.

Electricity Supply

MSL has played a significant role in bringing good measurement practice into the electricity industry. We ensure consumers can have confidence in the measurements that underpin the buying and selling of electrical energy, especially as new renewable energy sources are introduced. The increasing uptake of electric vehicles presents a new challenge, requiring new measurement methods to accurately quantify the energy delivered during charging. MSL has the expertise to contribute to solving this problem.

Consumer confidence and trust is supported by the measurement traceability provided by MSL, enabling the regulation of legislation to protect consumers, and reducing exposure to lower quality goods and services.

Measurement Standards Laboratory
of New Zealand

- Delivers R&D services directly to NZ industry (e.g, how to optimise groundcovers for horticulture)
- Maintains official New Zealand time
- Smooths access to market by providing evidence of compliance with international regulations
- Underpins the reliability of **> 600** testing and calibration laboratories' services across NZ
- Provides temperature and humidity references to support weather forecasting
- Allows the gold kiwifruit industry to guarantee product quality through pre-harvest colour measurements
- Helps NZ monitor water and primary produce quality by calibrating reference equipment for testing laboratories
- Protects consumers by enabling MBIE Trading Standards to verify volumes dispensed at fuel pumps

MSL Services and Functions

MSL ensures New Zealand's units of measurement are consistent with the International System of Units (SI). It provides New Zealand with the most accurate calibration services in the country for a wide range of instruments and equipment. In addition to this, MSL carries out many other functions, ensuring the smooth functioning of New Zealand's national measurement system.

MSL carries out research to improve the international system of measurement units (SI), solves measurement problems in industry and government, and provides advice and training to ensure equipment can be used effectively by customers. MSL also plays a key role in ensuring international recognition of New Zealand's national measurement system, which is essential for New Zealand's ongoing international trade.

MSL's key functions are to:

- Maintain measurement standards
- Calibrate equipment
- Solve research and development problems
- Provide training and advice to industry
- Develop new measurement technology
- Represent New Zealand's interests internationally
- Participate in international measurement comparisons and collaborations
- Provide technical leadership in measurement science.

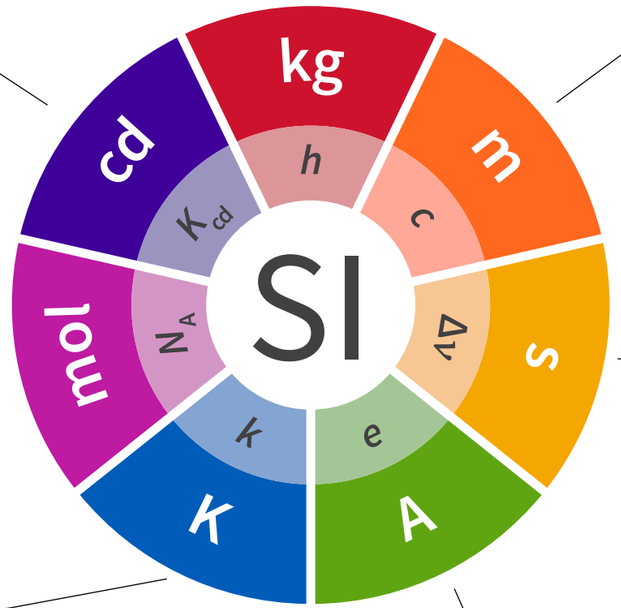
MSL provides measurement expertise and provides New Zealand with uniform units of measurement in the following areas:

Mass and Related Quantities

MSL maintains capability in mass, pressure, density, and volume measurements. The team can also provide advice on the measurement of other mass-related quantities, such as flow, force, torque, and hardness.

Photometry and Radiometry

The team builds and maintains measurement scales in photometry, radiometry, and spectrophotometry. They can calibrate and characterise light-measuring instruments, light sources, and optical properties of materials from the ultraviolet through to the near infrared.



Length

MSL provides traceable calibrations of a range of artefacts and instruments at various size scales, from end standards, diameter standards, roundness standards, and line scales to surveying instruments and microscopy standards. MSL also has capability in three-dimensional coordinate metrology, and can solve complicated measurement problems for New Zealand industry.

Time and Frequency

The team maintains NZ's realisation of legal time using atomic clocks. Designated UTC(MSL) – NZ time legally defined in relation to UTC – it is monitored continuously through information we supply to the BIPM Time Department and is reported monthly in the BIPM's Circular T bulletins.

Temperature and Humidity

MSL covers contact thermometry, radiation thermometry, and humidity. We can help you to understand limitations in the accuracy of industrial thermometers, identify errors in applications of radiation thermometry, and improve the accuracy of humidity measurements.

Electricity

A wide range of capability is found in MSL, primarily for standards of AC and DC current and voltage, resistance, capacitance, inductance, power, and energy. We also offer support for businesses making energy measurements in compliance with the Electricity Industry Participation Code.

Strategic Themes

1.Enhance MSL's Role as a World Class National Metrology Institute

Build on the recent investment in facilities, equipment, and new employees to ensure MSL continues to utilise a world-best-practice model for operating as an NMI and remains nationally and internationally relevant.

Goals during 2022 – 2027

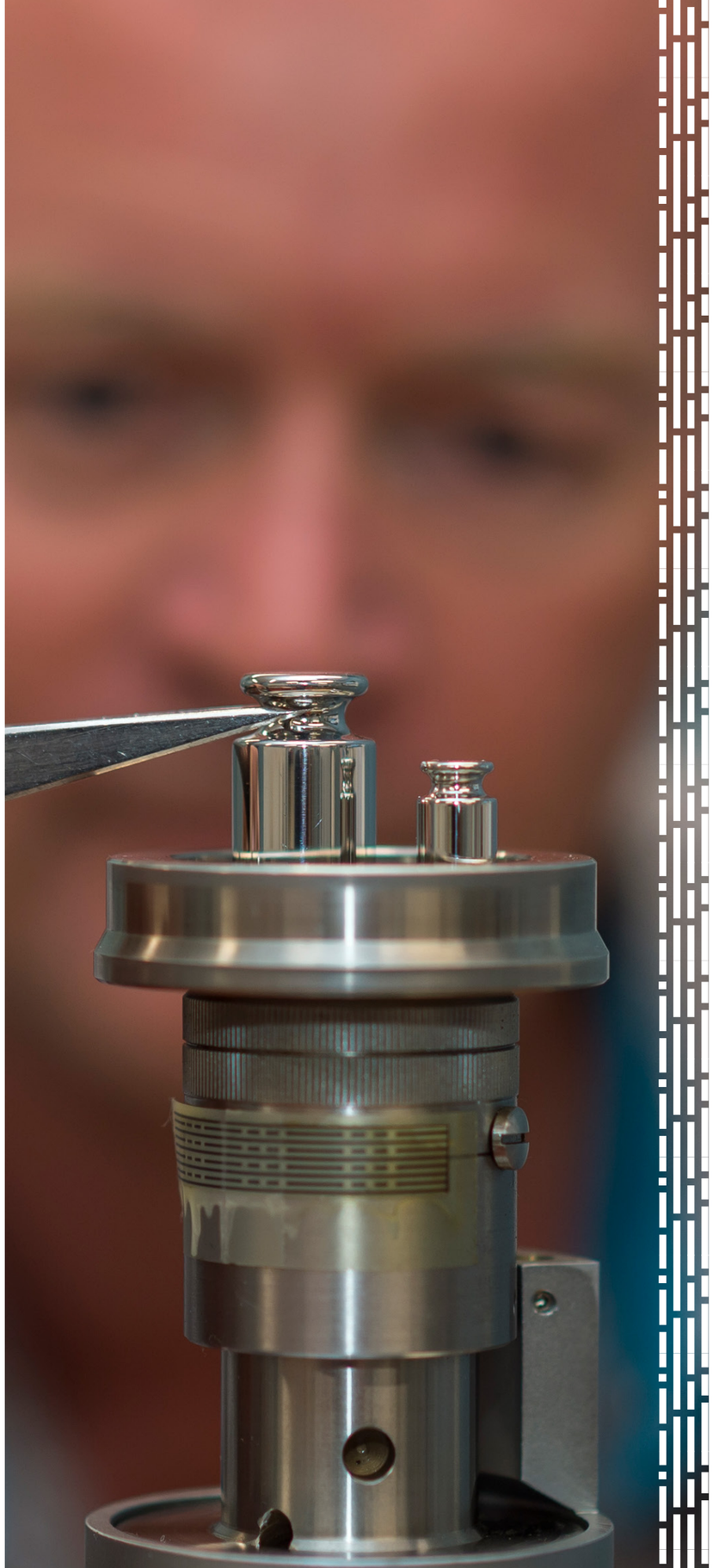
- Ongoing maintenance and provision of primary standards of measurement for New Zealand.
- Mātauranga Māori in the field of measurements is understood and celebrated.
- Internationally recognised research scientists in all MSL standards areas.
- Enhance MSL's contribution to the global metrology ecosystem.

Desired outcomes

- MSL has a balanced portfolio of commercial services, research projects, and contributions to international metrology.
- Ongoing dissemination of measurement standards to independent laboratories and other users through calibration services.
- Access to and knowledge of the national quality infrastructure, in particular MSL services, is equitable for all of Aotearoa New Zealand.
- MSL makes significant contributions to the advancement, governance, and development of international metrology and has excellent relationships with fellow NMIs.
- Our people are engaged and empowered to contribute to the scientific direction of MSL, and strong processes are in place to continue their development as metrologists.
- New Zealand's measurement system is accepted and respected nationally and internationally.
- The story of measurement standards in Aotearoa New Zealand includes indigenous measurement and knowledge.
- Our service delivery to customers is efficient and meets their expectations every time.

How we might do this

- Development of our people and succession planning for the future.
- Build and strengthen relationships with iwi, whānau, and hapū Māori, in particular those with expertise and knowledge in indigenous measurement.
- Work closely with Gracefield Innovation Quarter to continue the development and upgrade of laboratory facilities to meet MSL requirements.
- Build and strengthen the relationship between MSL and other national metrology institutes and technical committees.
- Participation in international comparisons with results as good as or better than our CMCs.



Pressure

Tens of thousands of pressure calibrations performed each year can be traced back to MSL's pressure standards, either directly or via 16 accredited laboratories. Each calibrated device is used to make countless pressure measurements in areas such as safety, health, meteorology, defence, construction, oil and gas, food, aviation, and manufacturing.

For example, a single calibrated barometer for one of our District Health Boards (DHBs) may be used to help determine the precise dose of radiation required to save hundreds of cancer patients. Alternatively, accurate calibration of one water backflow prevention tester can be used to ensure the safety of drinking water for thousands of New Zealanders.

Strategic Themes

2. Build MSL's Leadership and Influence in the National Quality Infrastructure and Science Ecosystem

Develop the brand and reputation of MSL to be proactively sought out to contribute technical advice to government, industry, and international science forums.

Goals during 2022 – 2027	• Build and expand recognition of MSL and the role of measurement science (metrology) across industry, government, and science ecosystems. • Chief Metrologist and Senior MSL scientists are recognised for their expertise within both the quality infrastructure system and government. • Provide technical advice to New Zealand industry.
Desired outcomes	• MSL employees have the confidence and backing to proactively raise measurement issues of national or consumer relevance. • New Zealand benefits from enhanced knowledge of measurement-related matters, particularly where they impact consumer decision making and international trade. • The pool of organisations MSL partners and collaborates with grows over the next five years. • Collaboration (across MSL, Callaghan Innovation, and other external organisations) is a core component of how we do our work. • The trust, independence, and sovereignty of New Zealand's quality infrastructure remain strong.
How we might do this	• MSL employees attend and contribute to key technical meetings nationally and internationally. • MSL takes a leadership role in the National Quality Infrastructure system. • MSL proactively delivers information to keep industry, science, and government up to date on metrology-related matters. • Review and expand training courses to help develop commercial calibration laboratories. • Ongoing support to government regulators.

Temperature

MSL contributed to an international task group developing best-practice guides for the use of radiation thermometry to measure human body temperature. This enabled effective screening of people for fever, and provided a tool for managing the COVID-19 pandemic, which can be applied for use in any future pandemics.

Guides were written for infrared ear and forehead thermometers, along with thermal imaging systems, which allow users of these instruments to avoid the many pitfalls often associated with such measurements.
The guides were reviewed by medical practitioners and are available publicly on the International Bureau of Weights and Measures (BIPM) website.

Strategic Themes

3. Contribute to the Evolution of Metrology

Take a leading role nationally and internationally in developing new measurement techniques and applying metrology principles to new areas.

Goals during 2022 – 2027

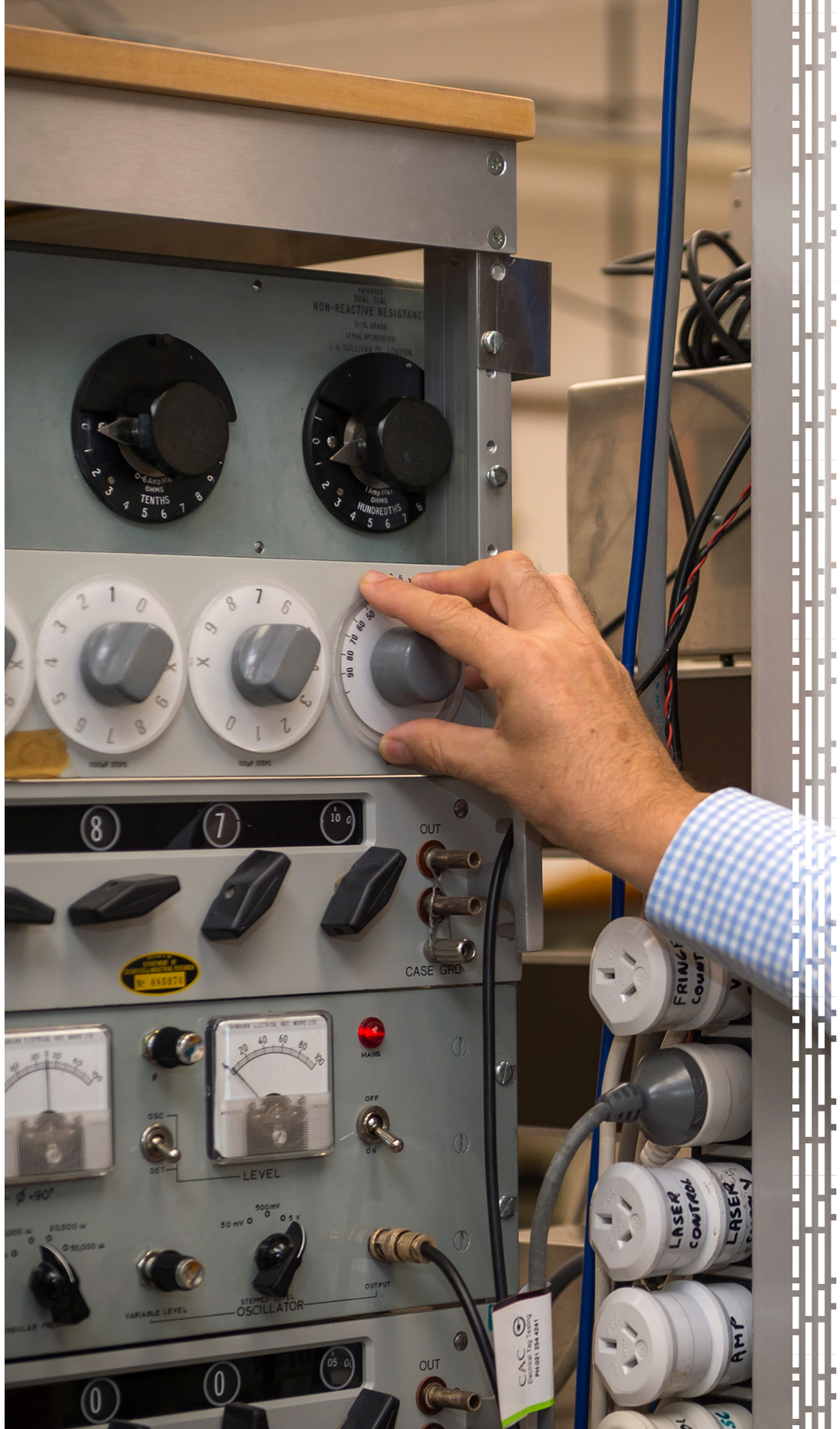
- Our expertise is understood and valued. We know where and how we can add value.
- Focus on development of new measurement technology.
- MSL is able to respond and contribute quickly to the needs of New Zealand as well as to international advancements and changes in metrology.

Desired outcomes

- A solid understanding of what metrology is, and how to think of our capability beyond being a calibration service and the services we deliver today.
- All new Callaghan Innovation solutions or missions consider the benefit of metrology and liaise with MSL before commencing. (Metrology expertise is offered as a core component of Callaghan Innovation services to customers.)
- The influence of good metrology principles spans beyond the areas of core metrology, so all projects are able to benefit from increased understanding of uncertainty and evidence-based decision making.
- The increased adoption of metrology principles enhances all areas of science where measurement is required.
- Our exploration of new measurement techniques and the application of metrology principles to areas outside of metrology enhances our ability to deliver our core services to New Zealand.

How we might do this

- Build connections within Callaghan Innovation to enable MSL to contribute core metrology expertise to new ‘solution projects’ (e.g, Cleantech, Industry 4.0).
- Contribute to international research and advance the development of MSL’s Kibble Balance.
- Build knowledge of Quantum Metrology.
- Contribute internationally to the development of digital metrology and seek ways to implement this in the National Quality Infrastructure.



Collaboration in the New Zealand Science Innovation Ecosystem

The Measurement Standards Laboratory is a business unit of Callaghan Innovation. Operating as a science group within this context provides numerous advantages to MSL.

Key amongst these is the ability to leverage the wider connections of Callaghan Innovation into the science ecosystem, advancing the use and benefits of metrology to New Zealand business, industry, and innovation. Over the coming years, MSL, will continue to focus on identifying mutually beneficial collaboration opportunities to work with other parts of the research, science, and innovation sector.

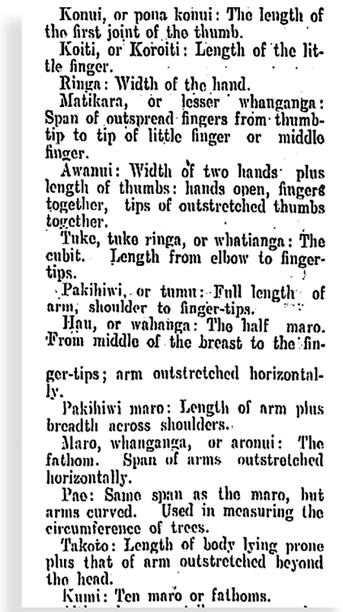
Callaghan Innovation's operating and business models continue to evolve, enabling greater collaboration and building innovation capability across the ecosystem. MSL will embrace these changes, and seek new opportunities to provide input from our metrologists to all solutions and products offered by Callaghan Innovation, and across the wider research science and innovation sector.

MSL's measurements underpin the health and wellbeing of New Zealanders all day every day

Rediscovering measurement systems used by Māori

A fascinating student research project supported by Measurement Standards Laboratory (MSL) found Māori developed a unique decimal numbering system and used a standard measure of length.

The study was inspired by historical accounts mentioning Māori measures of length. Historian Elsdon Best (1856 – 1931) wrote that Māori had a measurement system based on using the distance between different parts of the human body. East Coast Māori used the span of the bodies or limbs of senior leaders as standard measurements. This system was used in building waka, whare, and other structures.



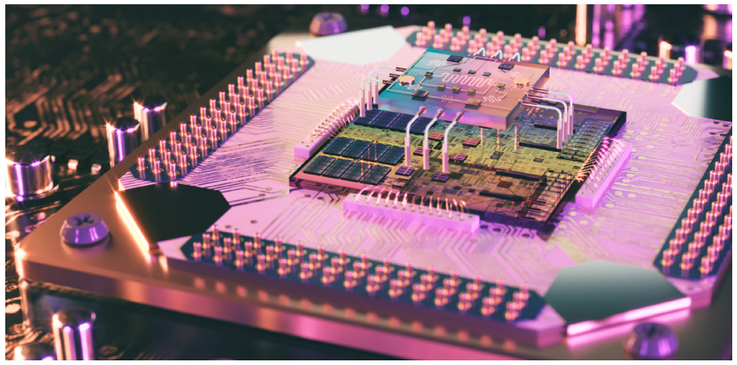
Konui, or pona konui: The length of the first joint of the thumb.
Koiti, or Koroiti: Length of the little finger.
Ringa: Width of the hand.
Matikara, or lesser whanganga: Span of outspread fingers from thumb-tip to tip of little finger or middle finger.
Awanui: Width of two hands plus length of thumbs: hands open, fingers together, tips of outstretched thumbs together.
Tuke, tuke ringa, or whatianga: The cubit. Length from elbow to finger-tips.
Pakihiwi, or tumu: Full length of arm, shoulder to finger-tips.
Hau, or wahanga: The half maro. From middle of the breast to the finger-tips; arm outstretched horizontally.
Pakihiwi maro: Length of arm plus breadth across shoulders.
Maro, whanganga, or aronui: The fathom. Span of arms outstretched horizontally.
Pao: Same span as the maro, but arms curved. Used in measuring the circumference of trees.
Takoto: Length of body lying prone plus that of arm outstretched beyond the head.
Kumi: Ten maro or fathoms.

Victoria University of Wellington student Te Aomania Te Koha reviewed the literature and uncovered many interesting examples of body-based measurement in use. An 1823 account by Captain Cruise describes a Māori chief measuring his ship by prostrating himself with arms extended above his head, marking where his hands fell and counting how many prostrations it took to cover the ship's length. This measurement is also reported by Best, who calls it the takoto, a word that translates as "to lie down".

Te Koha's research also points to Māori use of a decimal system. One kaumātua (elder) she interviewed mentioned hearing that everything in the meeting house on Whareponga Marae was in groups of tens. Another body measurement mentioned by Best, the maro, was a unit meaning the span of the arms outstretched horizontally. 10 maro made a kumi (around 18 metres), suggesting a base-10 counting system.

The research, published in a joint paper by Te Koha and MSL's Dr Farzana Masouleh can be accessed here.

Quantum Metrology



The International System of Units was updated in 2019 and is now based on the exact values of seven fundamental constants. Implementation of these units rests on quantum metrology, which requires a modern description of measurement, with a radical reappraisal of traditional measurement concepts.

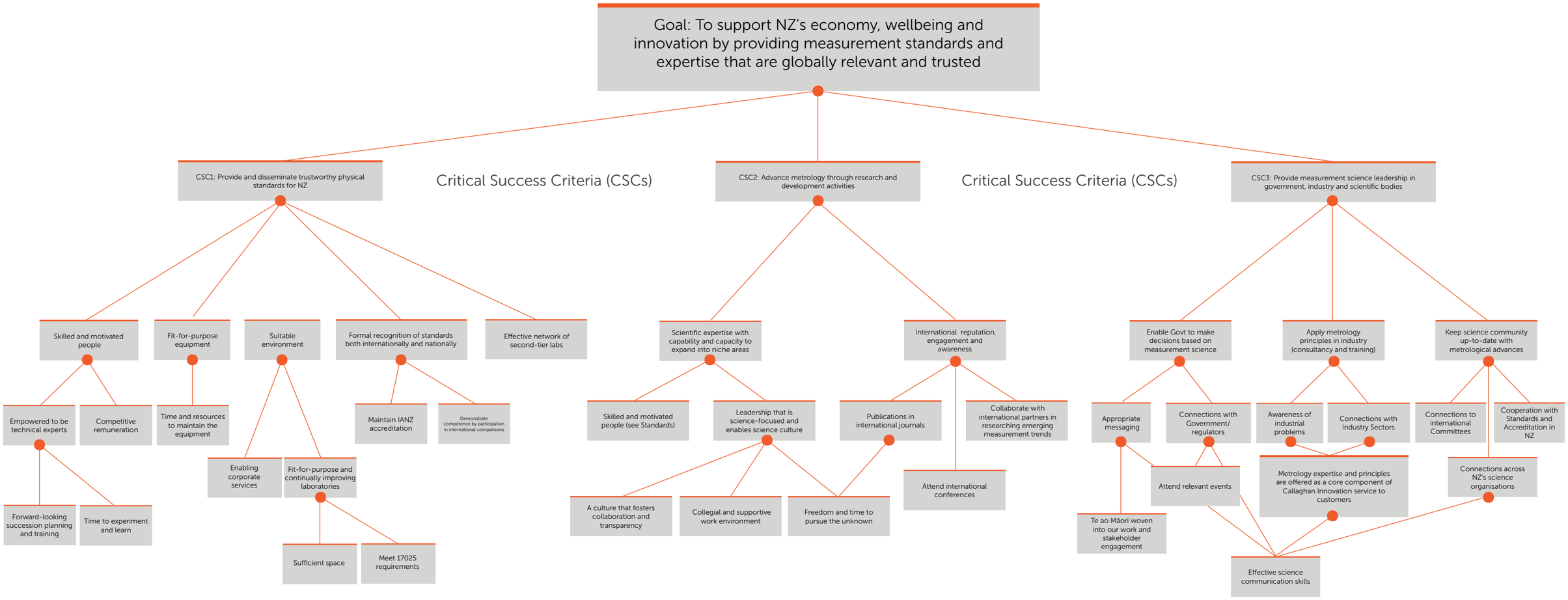
Quantum metrology also plays a key role in the development of emerging quantum technologies, which are based on the measurement and manipulation of individual quantum objects, such as atoms, electrons, photons, and flux quanta.

Quantum physics has already given us the electronic devices that control the fabric of our world. In the same way, the new quantum technologies are expected to provide the next generation of products with amazing properties. These range from powerful medical imaging devices to entirely new methods of computing that will enable solutions to currently intractable problems, which will profoundly affect our lives. Quantum technologies will have a major impact on communications, defence, sensing, finance, aerospace, and other industries.

MSL will continue to make contributions to the international development of fundamental aspects of quantum metrology, along with the output of the Dodd-Walls Centre of Photonic and Quantum Technologies. Working with the New Zealand Defence Force and the Five Eyes partners, MSL will also contribute to aspects of quantum technologies that are of relevance to New Zealand's national security.

Successful technologies are predicated on precise engineering, which in turn requires high-precision measurement. MSL's research and development of quantum metrology will aim to enable the commercialisation of advanced quantum technologies in New Zealand, ensuring the long-term growth of this knowledge-intensive industry sector.

MSL Goal Tree



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