The Reference.

Switzerland's metrology magazine

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METAS

Legal notice

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Cover
Commemorative medal awarded to mark the 150th anniversary of the Metre Convention and the founding of the International Bureau of Weights and Measures (BIPM) (1875–2025).

Content

Editorial

Dear reader,

150 years ago, representatives of 17 nations, including Switzerland, signed the Metre Convention in Paris. This treaty not only led to the founding of the International Bureau of Weights and Measures (BIPM), it also signalled the creation of one of the very first intergovernmental organisations.

Through the transition to nature-based units, it enabled the signatory states to move away from the great heterogeneity of anthropometric reference values. The last milestone in this development was the redefinition of the International System of Units (SI) in 2019. Since then, units of measurement have been completely dematerialised. Today, it is theoretically possible to reproduce a metre or a kilogram anywhere in the universe.

With its aim of establishing uniformity and universality, international metrology contributes to international understanding and peace. Due to their unifying effect, the SI and metrological values are an excellent antidote to geopolitical tensions.

In this edition, you will learn, among other things, how the Metre Convention still influences metrology today. Happy reading!

Dr Philippe Richard
Director
Federal Institute of Metrology METAS

Metrology in general

150 years of the Metre Convention “À tous les temps, à tous les peuples”

The International Metre Convention is a milestone in the development of metrology. It is one of the first international treaties and forms the basis for the creation of the International System of Units (SI), which is now the binding global standard for measurement. But one of the biggest achievements of the Metre Convention was to enable the creation of an internationally coordinated metrology infrastructure.

Dr Jürg Niederhauser

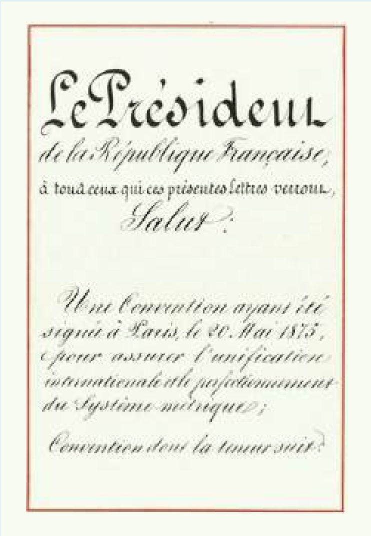
A kilogram is a kilogram everywhere – for us, this is a completely trivial statement today. Similarly, it goes without saying that a company can order components from a wide range of suppliers in different countries and receive them in the dimensions and with the accuracy specified in the order. This is possible because everyone involved refers to a globally binding basis for measurement: the International System of Units (SI).

The human body as a reference

People have always measured. One way of taking measurements was to use reference values, which were based on containers such as barrels and bags. But one of the most popular solutions was for people to use themselves as a measure. As a result, there were many units of measurement derived from the human body, such as a span (the width of a hand with fingers spread apart), an inch, a yard, an ell and a foot.

At first, measurement was a local matter. And the same is true of the definition of units of measurement. For reference measurements derived from the human body, measurements were usually taken from a ruler of a town or region. People can differ considerably from one another in terms of their build. Over time, this gave rise to a variety of units of measurement that existed side by side. They varied from principality to principality and often even from town to town. Despite having the same name, a unit of measurement could represent different measures of the same quantity depending on the region. The unit of length “foot”, for example, was common in many places, but it was by no means the same length everywhere. Even at the beginning of the 19th century, the unit “foot” still existed in countless regional and country-specific dimensions in what is now modern-day Germany.

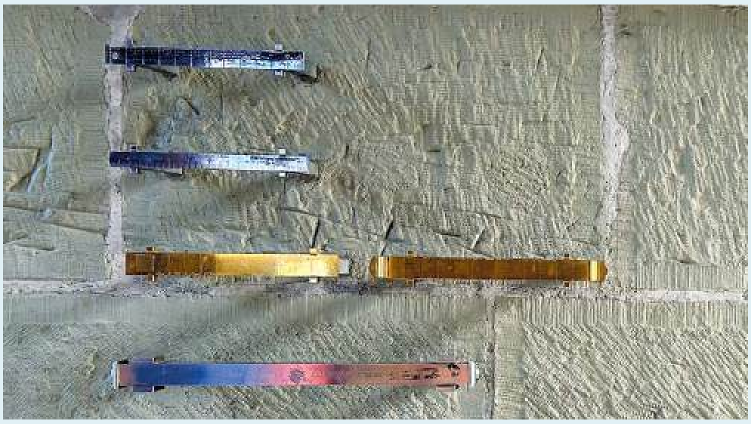
With the committee metre and the committee kilogram (cast-iron copies of the “mètre des archives” and the “kilogramme des archives”), the metric system was broadened from 1800. On the left you can see the committee metre and the committee kilogram of Switzerland, and at the top is a section of the committee metre box.



Le Président
de la République Française,
à tous ceux qui ces présentes lettres verront,
Salut:

Une Convention ayant été signée à Paris, le 20 Mai 1875, pour assurer l'unification internationale et le perfectionnement du Système métrique;

Convention dont la teneur suit:



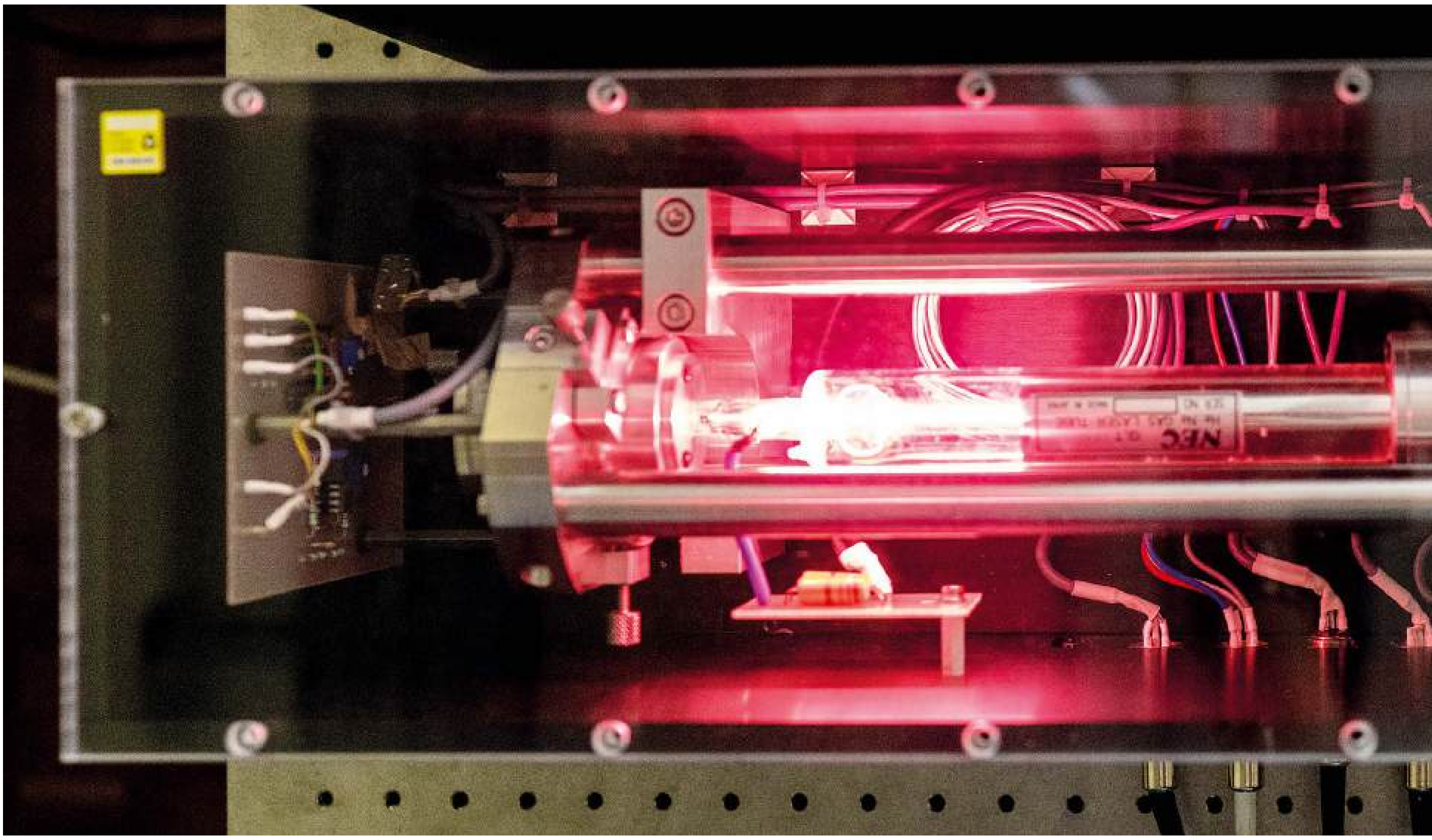
Preamble to the Metre Convention (left). Old reference dimensions for length in the passageway of the Zytglogge tower in the city of Bern (right).

The Earth as a measure

With advances in science and technology and the expansion of trade relations, in the 18th century the diversity of units of measurement was increasingly seen as an obstacle to be overcome. Instead of using thousands of different masses and weights, people started to consider the possibility of measuring with a system of uniform masses and weights.

In 1790, the French National Assembly decided to develop a new, standard unit of length. A system of uniform weights and measures based on the decimal system was planned: the metric system. The reference for the unit of length was no longer to be the human body, nor something related to a particular nation, but the Earth itself. In March 1791, a scientific commission, which included physicist Pierre-Simon Laplace and mathematicians Joseph-Louis Lagrange and Antoine de Condorcet, proposed defining the new unit of length, the metre, as one ten-millionth of a quarter of the circumference of the Earth on a meridian, that is, the distance from the North Pole to the equator. In 1792, the two astronomers Pierre François André Méchain and Jean Baptiste Joseph Delambre began to measure part of this quadrant, namely the distance between Dunkirk, Paris and Barcelona, as accurately as possible, in order to determine the new unit of measurement, the metre, based on the results of these measurements.

The two astronomers Jean Baptiste Joseph Delambre (left) and Pierre François André Méchain (right) in 1792.



Under most challenging circumstances in the midst of the tumultuous French Revolution with its military unrest, they carried out their measurements for seven years. Based on the evaluation of their measurements, which were validated by an international commission, a reference measure for the new unit, the metre, was established in 1799: the platinum "mètre des archives", a measure for all times ("À tous les temps, à tous les peuples").

The demands of the Industrial Revolution

Copies of this "mètre des archives" and the "kilogramme des archives" were made in cast iron, known as committee metres and committee kilograms. From 1800 onwards, the metric system gradually spread to France's neighbouring countries and other countries. In some cases, old units of measurement remained in use alongside metric units. This is not least because determining the size of the units of measure was often a subject of political debate at the time.

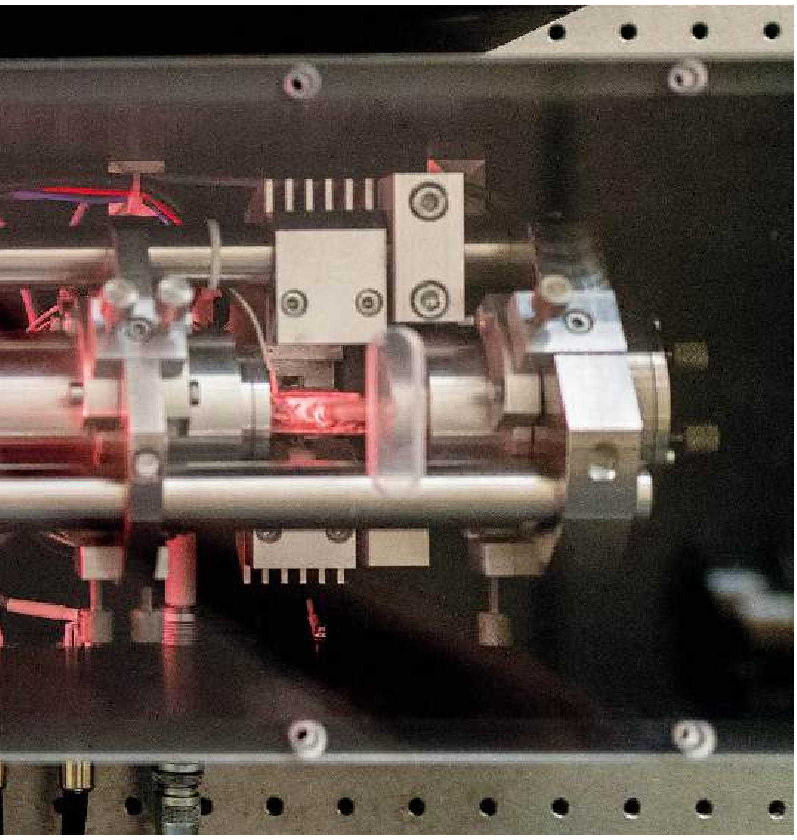
With increasing industrialisation and the associated expansion of international trade, the coexisting units of measurement that had become established over time were increasingly seen as overly complex and a hindrance to trade and development. Accordingly, the standardisation of measurement systems became a key economic policy concern. It also became apparent that better reference measures for the new units were needed. In the second half of the 19th century, this led to all of the rival nation states, despite their sometimes fierce political disputes, simultaneously striving to standardise units of measurement and create new reference measures at the international level.

The International Metre Convention

A decisive step in this direction was taken by the International Metre Commission, which met in Paris in the autumn of 1872. It laid the foundations for the Diplomatic Metre Conference of 1875, which culminated in the signing of the Metre Convention on 20 May 1875. Seventeen founding countries, including Switzerland and the USA, signed the Metre Convention; today, 64 countries are signatories and a further 37 are associated members.

The Metre Convention is one of the first international treaties under international law, which also highlights the importance of uniform and regulated units of measurement.

The Metre Convention established the *Bureau international des poids et mesures* (BIPM), a collaborative and jointly financed office of the contracting states.



Today's metre base: the metre is produced in a laboratory with the help of a helium neon laser.

In 1889, the new reference measures for the unit of length and the unit of mass were completed and validated. Reference measure No. 1 was kept at the BIPM as the authoritative prototype of the relevant unit (prototype international du mètre / International Prototype of the Metre and prototype international du kilogramme / International Prototype of the Kilogram). The other copies of the reference measure were distributed by lot to the contracting states as national copies of the international prototypes. Switzerland received copy No. 2 of the international prototype metre and copy No. 38 of the international prototype kilogram.

Above all, the Metre Convention also made it possible to establish an internationally coordinated metrological infrastructure: at the international level the bodies of the Metre Convention, in particular the BIPM. At the national level, these are matched by the national metrology institutes, which are at the forefront of measurement accuracy in their respective countries – in Switzerland, this is METAS. Cooperation between the national metrology institutes and the bodies of the International Metre Convention ensures that the reference measures in a country are internationally recognised and are available with the required accuracy.

Continuous development

The purpose of the Metre Convention is briefly outlined in its preamble: "Désirant assurer l'unification internationale et le perfectionnement du système métrique…" ("Desiring the international unification and improvement of the metric system…") This introduction alone makes it clear that it is not just a matter of defining an internationally uniform system of units once and for all. Rather, this system of units must be constantly adapted to the latest requirements in line with scientific and technical progress. This applies to the definition of individual units as well as to the system of units. In 1960, for example, the metre was defined not by reference to a standard such as the international prototype, but rather by reference to a physical phenomenon, a wavelength. This made it possible to realise the unit of the metre with greater accuracy. Even greater precision was made possible by defining the metre with reference to a natural constant, the speed of light, which came into force in 1983.

In 1960, at the 11th General Conference on Weights and Measures, an expanded metric system, the Système international d'unités (SI), was introduced. Today, the SI is the globally accepted basis for measurement. With the revision of the SI, which came into force on 20 May 2019, the kilogram was also defined by a natural constant.

The importance of an internationally coordinated metrological infrastructure, which was created with the Metre Convention, cannot be overstated. This is particularly true because it was also designed to enable the system of units to be continuously developed.

Metrology in general

100 years of quantum mechanics: from the inconceivable to the essential

2025 is a special year for science: the International Year of Quantum Science and Technology and 150 years of the Metre Convention. A look back at the beginnings of quantum mechanics – a theory that still shapes our lives today.

Dr Hugo Lehmann

In 2025, while the global metrology community is celebrating the 150th anniversary of the Metre Convention – the birth of the International System of Units –,[1] another anniversary is also coming up this year: UNESCO has declared 2025 the International Year of Quantum Science and Technology.[2]

Around 1900, not all physical phenomena at the atomic and subatomic level could be described satisfactorily with classical physics. New explanatory approaches were being sought. This is how quantum mechanics emerged 100 years ago, and today it is an essential foundation of physics.

At the end of the 19th century: physics enters a new era

Since time immemorial, people have been fascinated by the colours of the rainbow, the continuous colour spectrum of visible light.

Since the mid-19th century, however, it was known that individual atoms do not emit a continuous spectrum, but only have discrete spectral lines. This could not be explained by the physics known at the time. The Swiss physicist Johann J. Balmer had devised a formula based on integers to calculate the discrete lines in the spectrum of hydrogen,[3] but the reason why it behaved this way was literally hidden in the dark.

This was not the only gap in the knowledge of physics at the end of the 19th century; the explanation of the continuous, electromagnetic spectrum of an ideal radiation body – known as a black body – was not theoretically understood. Max Planck set about solving this problem. To explain these continuous light spectra, he had to assume that the energy is not radiated continuously, but in discrete steps. He writes:[4]

...this is how we see that the energy element e must be proportionate to the oscillation number n, i.e.:

$$\varepsilon = h\nu$$

For the natural constant h, which is now referred to as Planck's quantum of action, he also calculates a value that deviates only slightly more than 1% from the value recognised today.

What does it mean? Is light divided into discrete portions? This seemed astonishing, because, since James C. Maxwell published his theory of electromagnetism in 1873,[5] light had been understood as an electromagnetic wave. How was this compatible with Planck's energy elements?

In 1905, Albert Einstein – who at the time was working at the Swiss Federal Patent Office in tranquil Bern – took up Planck's thoughts on explaining the photoelectric effect[6]. When light hits a metal plate, electrons are released, but not at every wavelength of the light. To explain this observation, Einstein now assumed that light can only be absorbed in quanta "as a whole".[7] Electrons can only escape from the metal surface if the energy of a quantum of light is greater than the binding energy of the electrons in the metal. Einstein received the Nobel Prize in 1921 for this work, in which he attributed a physical interpretation to Planck's energy elements.

The struggle to understand atomic spectra

While Einstein's idea of light quanta could explain the photo effect, it also led to a dilemma: was light a wave or a particle? Was light even a schizoid phenomenon and both things at once? This dilemma was transformed into the idea of wave-particle duality by Louis de Broglie in his doctoral thesis[8] in 1924. It means that light has both wave and particle properties. What was interesting about de Broglie's approach was that this applies not only to light, but also to elementary particles (e.g. an electron). This thesis was initially viewed with scepticism, but soon confirmed by experiments by Davisson and Thomson,[9] who were able to demonstrate that electrons generate interference patterns analogous to waves. Elementary particles can therefore also be understood as wave packets.

This did not make the whole question any easier to answer, but all the elements were now together to solve the mystery of the discrete spectral lines of atoms. The Austrian physicist Erwin Schrödinger took on this task in late 1925. At the time, Schrödinger was a professor at the University of Zurich and travelled to Arosa with a mystery lover[10] over the Christmas season. Whether it was the beautiful mountain scenery or the stimulating company, he found the necessary inspiration to shed new light on the problem of atomic spectra.

Back in 1913, Niels Bohr had postulated[11] that electrons orbit around the atomic nucleus. Only orbits with an energy corresponding to an integer multiple of Planck's quantum of action should be allowed. There were no grounds as to why this should be the case.

This is where Schrödinger came in. Ultimately, there were systems in classical mechanics too that only allowed certain states. Consider an alphorn, for example: only waves that correspond to an integer multiple of the fundamental frequency can occur in the conical tube. This is how the natural tone series is created. This property is determined by the preconditions of the system, i.e. the pressure on both sides of the horn is predefined. The wave inside the alphorn can therefore only form certain oscillation states, known as standing waves (see Figure 1).

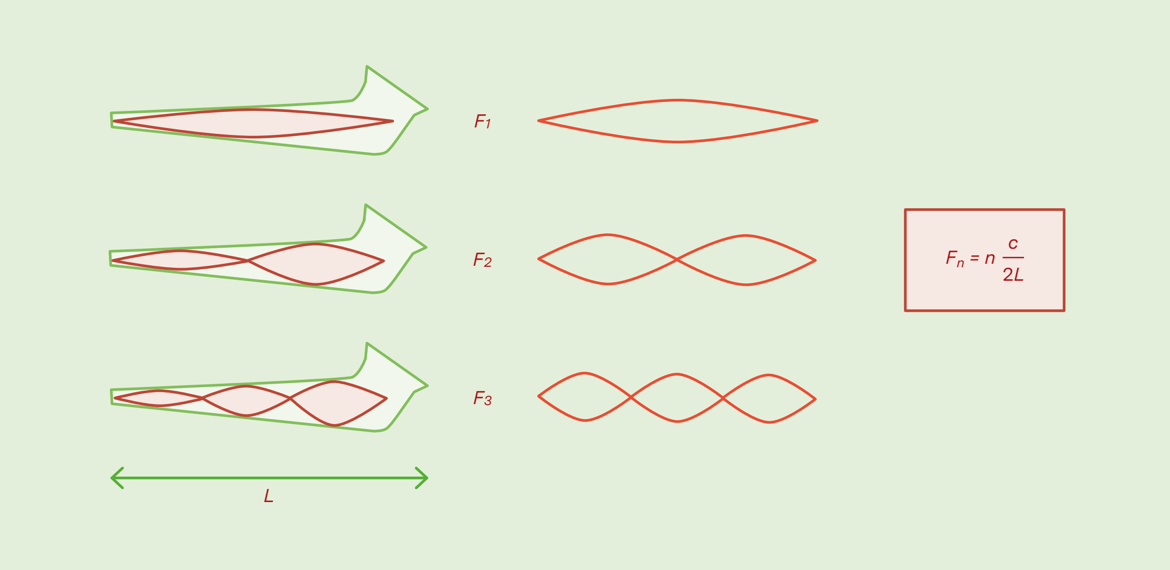


Figure 1. Left: vibration states in an alphorn of length L and the corresponding standing waves; right: frequencies of the natural tone series, where n is a natural number and c is the speed of sound

Schrödinger had noticed this behaviour of acoustic systems. He writes in the introduction to his original work:[12]

Instead, the integer results in the same natural way as, for example, the integer of the number of knots of a swinging string.

He understood the electron, which also has the nature of a wave due to the wave-particle duality, as a standing wave around the atomic nucleus. Schrödinger can describe the energy of these states with the famous wave equation named after him. Without Bohr's out-of-the-blue quantification rules, Schrödinger finds quantification as a solution to the wave equation. This is why Schrödinger's theory is called wave mechanics. The solutions of the Schrödinger equation yield spatial functions that describe the electron density in the orbitals in the atom.

The analogy of Schrödinger's wave mechanics with methods of classical physics may have been one reason why wave mechanics has been more favourably received and better understood than matrix mechanics, developed by Werner Heisenberg in Göttingen in 1925:[13] As the name suggests, Heisenberg's theory uses matrices to calculate the energy levels of electrons. After initial disputes over the correctness of one or the other theory, it was possible to demonstrate the equivalence of matrix and wave mechanics a few years later.

This laid the foundations for quantum mechanics in 1925. However, it took time to understand this groundbreaking theory and its implications. The confirmation from the experimental results and the applications such as lasers and semiconductor technology ultimately led to a broad acceptance of quantum mechanics.

Just the beginning

In the previous section, we discussed the first quantum revolution 100 years ago, which gave rise to the International Year of Quantum Sciences. In addition, the organisers of the quantum year 2025 also seek to raise public awareness of the importance of quantum mechanics in science and technology.

As quantification is an invariable standard firmly anchored in nature, the use of quantum effects in metrology is obvious. Over the course of the 20th century, for example, SI units were increasingly defined in metrology with the aid of quantum effects. Today, the second, the kilogram and the ampere are based directly on constants from quantum mechanics.

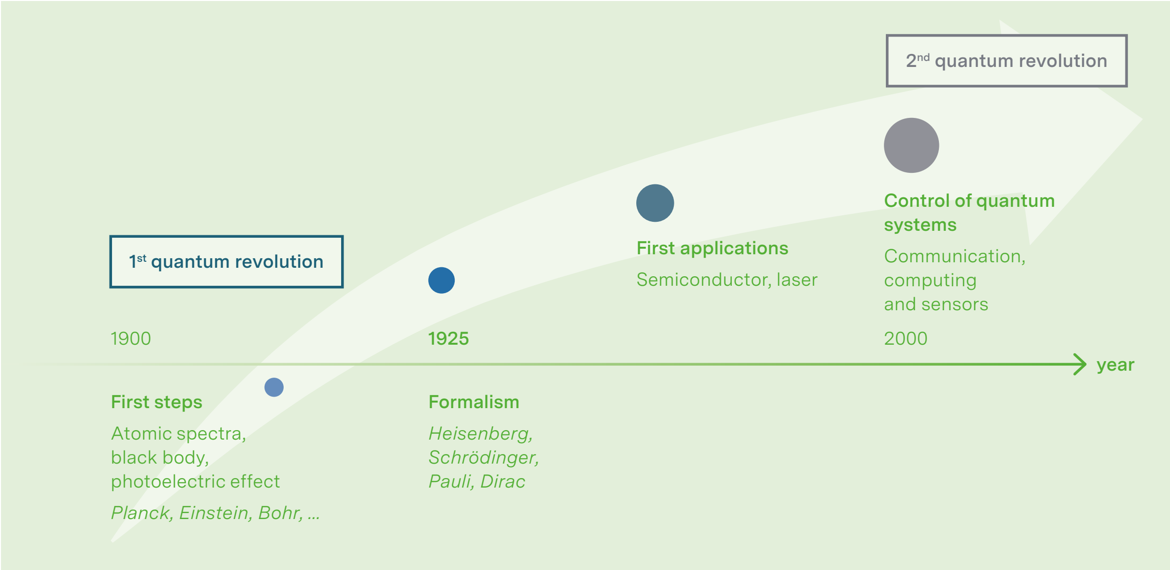


Figure 2. Development of quantum sciences and technologies over time

Ultimately, the new technological possibilities for controlling quantum systems in the three characteristic areas of quantum communication, quantum computers and quantum sensor technology mean that new applications are just around the corner. The so-called second quantum revolution will enable technological developments that will continue to have a significant impact on human life for the next 100 years.

2025: International Year of Quantum Science and Technology

The International Year of Quantum Science and Technology is under the auspices of UNESCO. The mission behind the International Year of Quantum Science and Technology is to use the 100th anniversary of quantum mechanics in 2025 to raise awareness of the importance and impact of quantum science and applications on all aspects of life. A wide range of activities have been and continue to be organised around the world to mark this occasion.

For more information, visit
https://quantum2025.org/events/

1 150 years ago, the Metre Convention was signed in Paris and the Bureau international des poids et mesures (BIPM) was established: https://www.bipm.org/en/bipm-anniversary
2 International Year of Quantum Science and Technology: https://quantum2025.org/
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4 Max Planck, Über das Gesetz der Energieverteilung im Normalspektrum [On the Law of Energy Distribution in the Normal Spectrum], Annalen der Physik [Annals of Physics], 309(3), 553 (1900)
5 James Clerk Maxwell, A Treatise on Electricity and Magnetism (1873)
6 Heinrich Hertz, Ueber einen Einfluss des ultravioletten Lichtes auf die elektrische Entladung [On the Influence of Ultraviolet Light on Electrical Discharge], Annalen der Physik und Chemie [Annals of Physics and Chemistry]. Volume 267, No 8, 983 (1887)
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11 Niels Bohr, On the constitution of atoms and molecules, The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science 26, 151 (1913)
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13 Werner Heisenberg, Über quantentheoretische Umdeutung kinematischer und mechanischer Beziehungen, Zeitschrift für Physik, [On the quantum-theoretical reinterpretation of kinematic and mechanical relations]. 33 (1), 879 (1925)

Service

Measurements of micro- and macroelements in dairy substitutes and meat substitutes

The Swiss Food Composition Database provides information on calories, nutrients and vitamins in food. The “Inorganic analysis and references” laboratory at METAS works with the Federal Food Safety and Veterinary Office and the Swiss Society for Nutrition (Schweizerische Gesellschaft für Ernährung, SGE) to analyse minerals in new food products, which are then included in this database.

Dr Silvia Mallia, Rafael Aubert and Dominik Rolli

In a world that is increasingly focused on sustainability, health and ethical consumption, plant-based alternatives to foods of animal origin are rapidly gaining in importance. The focus is particularly on dairy substitutes and meat substitutes, two fast-growing market segments that are changing our food culture and consumption habits in Switzerland and around the world.

Dairy substitutes (Figure 1) such as oat, almond, coconut or hazelnut drinks and meat substitutes (Figure 2) such as tofu and seitan offer a wide range of benefits: They are environmentally friendly, as their production requires lower CO_2 emissions and less water and land use. In addition, no animal husbandry or slaughter is required. Compared to dairy and meat products, these products also contain lower levels of saturated fatty acids and no cholesterol.

On the other hand, milk and meat substitutes are highly processed and contain additives and flavourings. The bioavailability of proteins and minerals, i.e. the body’s ability to absorb and utilise them, is often lower in these products than in dairy and meat products.[1] In addition, these plant-based alternatives are deficient in vitamin B_{12}. For this reason, some manufacturers fortify their products with synthetic vitamin B_{12}.

In this context, it is important to provide consumers with reliable information about these new foods. For this reason, as part of a collaboration with the Federal Food Safety and Veterinary Office (FSVO) and the Swiss Society for Nutrition (SGE), METAS has measured the mineral content of dairy substitutes and meat substitutes so that this data can be published in the Swiss Food Composition Database.

Figure 1. Examples of dairy substitutes, such as oat, almond, coconut or hazelnut drinks

Figure 2. Examples of meat substitutes: plant-based cutlets, nuggets and sausages

The Swiss Food Composition Database

The Swiss Food Composition Database is a comprehensive collection of data on the composition of foods (Figure 3) available in Switzerland. It is strategically managed and financed by the Federal Food Safety and Veterinary Office (FSVO), while the Swiss Society for Nutrition (SGE) is responsible for its maintenance on behalf of the FSVO. The database is publicly accessible at naehrwertdaten.ch. The database serves as a basis for research, dietary recommendations and policy decisions in the field of public health.

The current version (V 7.0) contains data on more than 1,100 foods. Information on macronutrients (e.g. protein, fat, carbohydrates), micronutrients (vitamins and minerals) and water, alcohol and energy content is available for each product. The database is available in four languages (German, French, Italian, English) and can be used free of charge. The Swiss Food Composition Database is regularly expanded and updated to incorporate new products and scientific findings.

Figure 3. The Swiss Food Composition Database is a comprehensive collection of data on the composition of foods available in Switzerland

Micro- and macroelements are essential

The “Inorganic analysis and references” (AAR) laboratory at METAS works together with the FSVO and the SGE and carries out analyses of micro- and macroelements in new food products, which are integrated into the Swiss Food Composition Database.

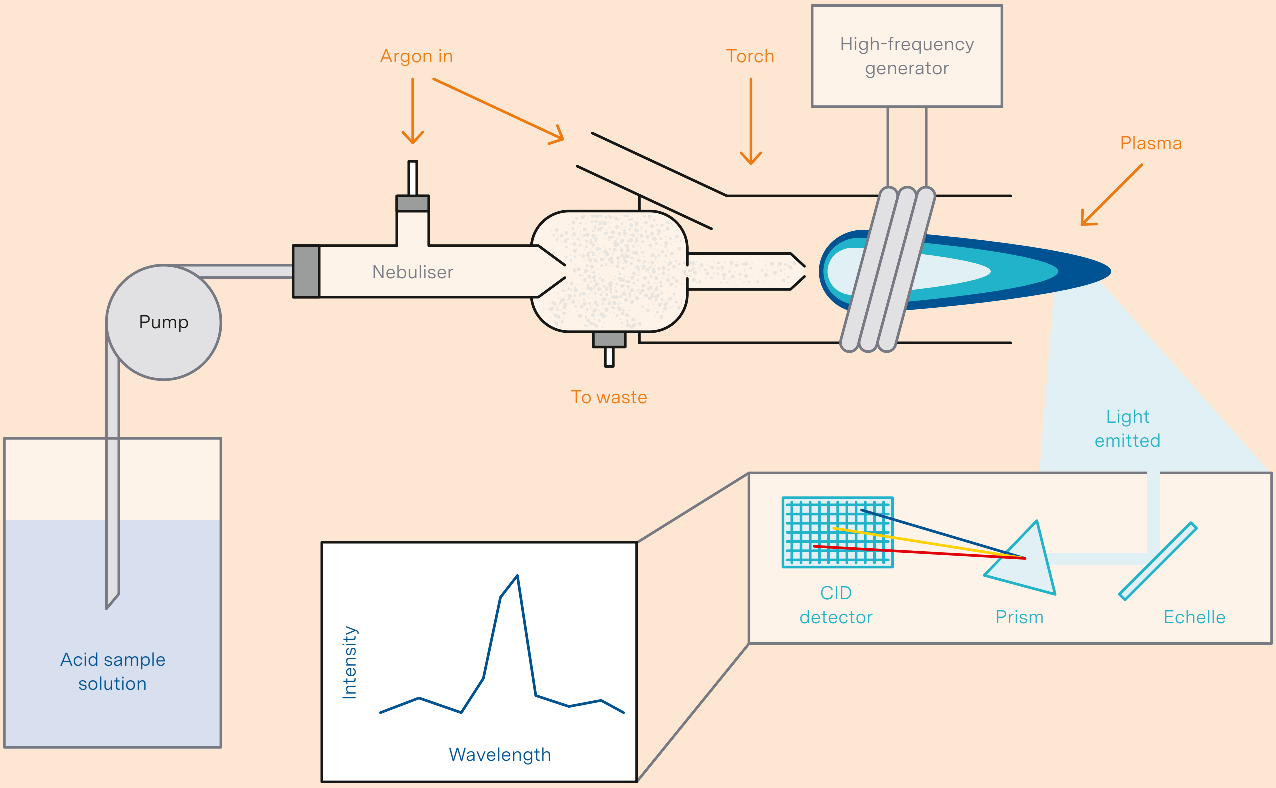
Macroelements are minerals required by the human body in relatively large quantities (more than 100 mg per day), such as calcium (Ca), potassium (K), magnesium (Mg), sodium (Na) and phosphorus (P). Microelements, also known as trace elements, are essential minerals such as iron (Fe), iodine (I), selenium (Se) and zinc (Zn), which the body only needs in very small amounts (less than 100 mg per day), but which are vital for many biological functions.

Measurements of around 60 products

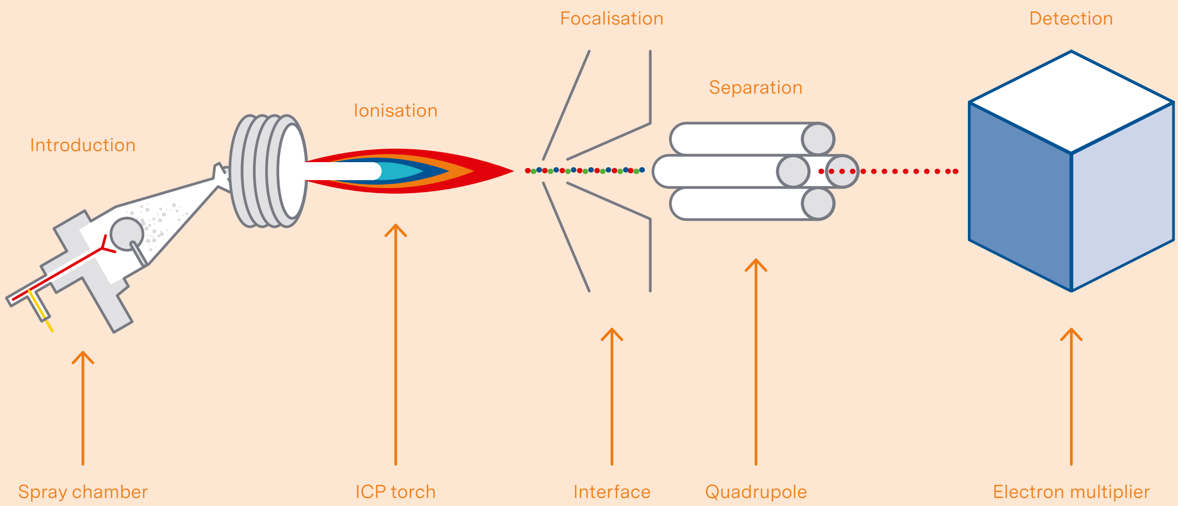
Specific methods for the analysis of micro- and macroelements in dairy and meat substitutes have been developed in the AAR laboratory. In particular, between 2023 and 2024, the AAR laboratory investigated micro- and macroelements in dairy and meat substitutes available on the Swiss market in order to expand the Swiss Food Composition Database with these new product categories.

Eighteen dairy substitutes (e.g. soy-, almond- and coconut-based yoghurt substitutes, quark and cottage cheese substitutes and cashew nut cheese substitutes) and 44 meat substitutes (e.g. burgers, nuggets and strips made from plant proteins, as well as seitan, Quorn and tempeh) were measured. In the first step, a small representative portion of the sample (200 mg) is treated with nitric acid and then completely broken down under high pressure and high temperature in a microwave digestion device.

Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES)



Inductively Coupled Plasma Mass Spectrometry (ICP-MS)



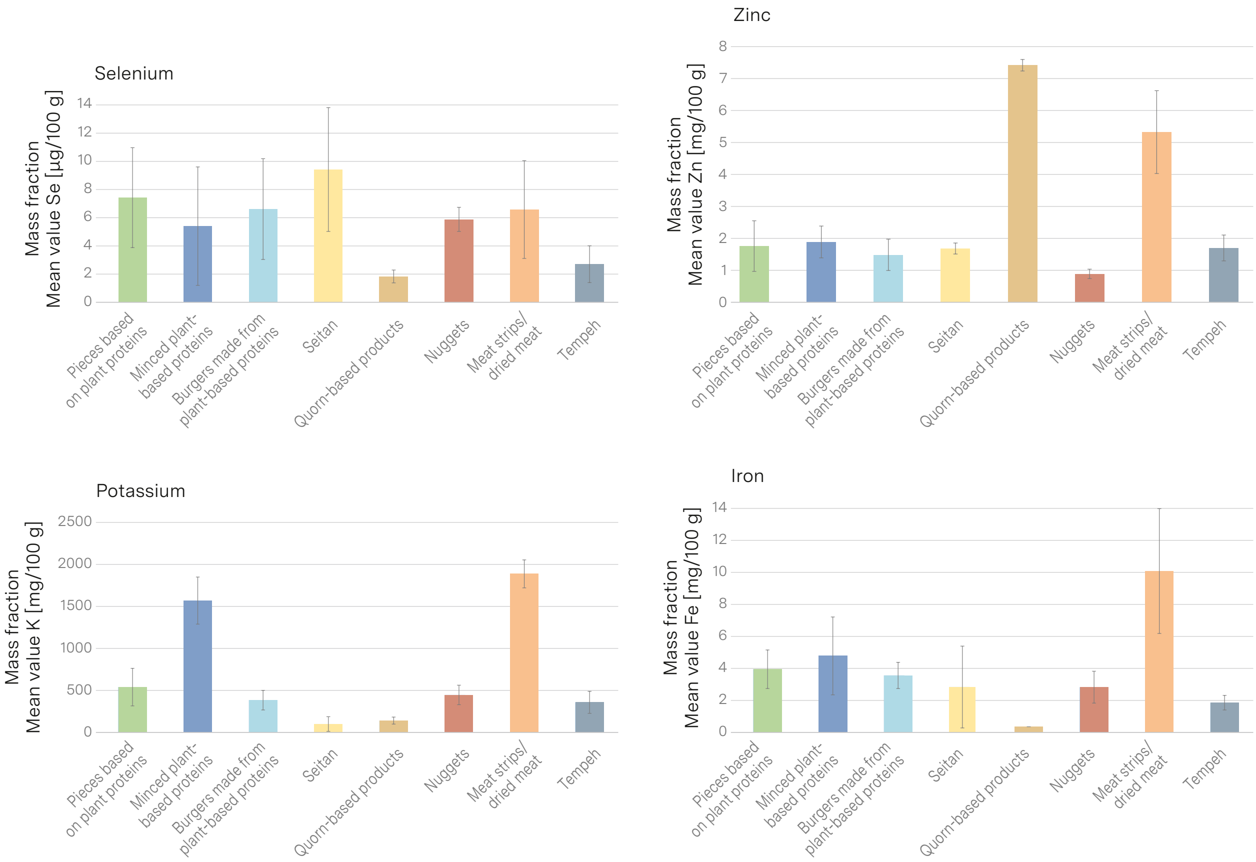
Calcium, iron, potassium, magnesium, sodium, phosphorus and zinc are then determined in the resulting solutions using inductively coupled plasma optical emission spectrometry (ICP-OES), and iodine and selenium using inductively coupled plasma mass spectrometry (ICP-MS). The two measuring principles are shown on the left-hand side.

Overview of results

Among the meat alternatives analysed, strips contained very high levels of potassium, selenium, zinc and iron, as shown in the graphs in Figure 4.

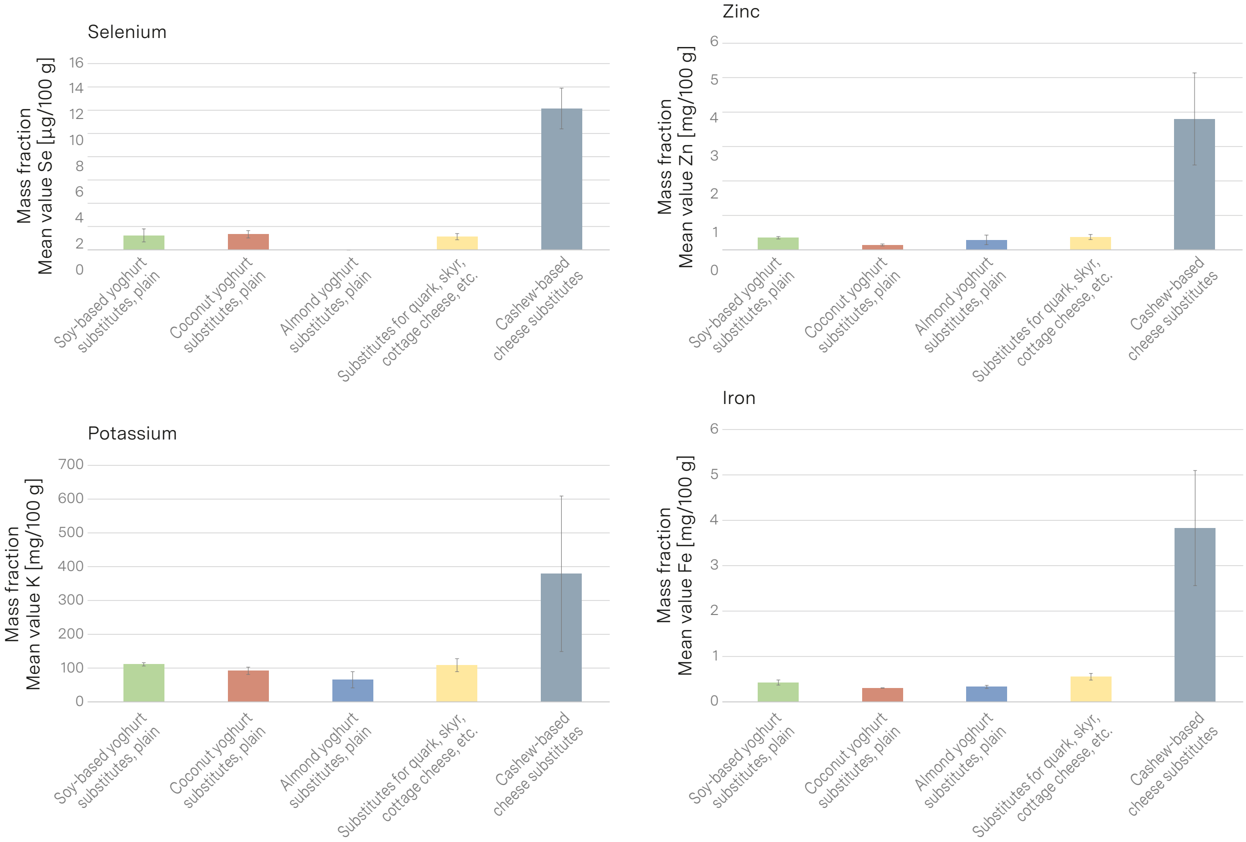
Cashew-based cheese alternatives contain a variety of macro- and micronutrients, most of which come from the cashew nuts themselves. Among the dairy substitutes, they stand out due to their high levels of potassium, iron, selenium and zinc, as shown in the graph in Figure 5. The strikingly high mineral content of cashew-based cheese alternatives may also be due in part to the significantly lower water content of these products.

The plant-based version made from soy or pea protein contains significantly more potassium, sodium, calcium, magnesium, phosphorus and iron than meat strips. The mycoprotein strips have a particularly high calcium and zinc content. However, they contain fewer minerals overall than the soy/pea variant. Meat strips provide the most selenium in comparison, an important antioxidant that is often found in only small quantities in plant-based products.



The standard deviation shown indicates the variation within a product category, which is often very high.

Figure 4. Selected micro- and macroelements in meat substitutes



The standard deviation shown indicates the variation within a product category, which is often very high.

Figure 5. Selected micro- and macroelements in dairy substitutes

Dairy and meat substitutes are good alternatives

Although plant-based meat alternatives are naturally rich in minerals, their release from the food matrix during digestion may be limited and therefore their absorption may be reduced.[1] Plant-based foods contain fibre, phytic acid and polyphenols, which can bind the minerals and potentially inhibit their release for absorption.[2]

Nevertheless, dairy and meat substitutes are a good alternative to animal-based foods and contribute to a varied and sustainable diet.

These macro- and microelement analyses of plant-based alternatives carried out by METAS make an important scientific contribution to the expansion of the Swiss Food Composition Database, which is a key tool for promoting healthy and informed nutrition in Switzerland.

1 K. Platel and K. Srinivasan, 2016, Critical Reviews in Food Science and Nutrition, 8398, 1608–1619
2 S. Rousseau, C. Kyomugasho, M. Celus, M. Hendrickx, T. Grauwet, 2020, Critical Reviews in Food Science and Nutrition, 60:5, 826–843

Object

Vase for metrologists

The French government presented each member of the International Metre Commission of 1872 with a personally inscribed vase from the state porcelain factory in Sèvres. One of these blue vases decorated with gold dust was given to Heinrich Wild, Director of the Eidgenössische Eichstätte (the predecessor of METAS) from 1867 to 1869. He participated as a representative of Russia because he had been director of the observatory in St. Petersburg and a member of the Academy of Sciences since 1868.

150 years of the Metre Convention

History of the metre in Switzerland

Metrology

1799

Mètre des archives and kilogramme des archives **“À tous les temps, à tous les peuples”.**

1872

International Metre Commission in Paris. (vase gifted by the French government)

1875

International Metre Convention, International Bureau of Meas-urements and Weights **(BIPM).**

1889

Prototype metres and prototype kilograms; distribution of national prototypes.

Switzerland

1835

Concordat of the cantons on a common Swiss measurement and weighting system.

Swiss foot

“The basis of the Swiss measurement system is the **Swiss foot,** which is exactly three-tenths of the French metre.”

1867

Adolphe Hirsch Conference of the international European Arc Measurement (Dir-ector of the Neuchâtel Cantonal Observatory; Secretary of the Inter-national Committee for Weights and Measures CIPM from 1875 to 1901).

1872

Heinrich Wild (Director of the Eidgenössische Eichstätte [METAS] from 1867 to 1869, delegate for Russia to the International Metre Commission, member of the Inter-national Committee for Weights and Measures CIPM from 1875 to 1902.)

1920

Nobel Prize for Physics for **Charles Édouard Guillaume** (worked at the BIPM from 1883 to 1936, Director from 1915 to 1936).

METAS

1862

The Federal Council votes to **establish a federal metrology institute** (Eidgenössische Eich-stätte) (foundation of METAS).

1909

Federal Office for Mass and Weight (Eidgenössisches Amt für Mass und Gewicht).

1914

Building on Wildstrasse in Bern’s Kirchen-feld district.

1948

Redefinition of the unit of electrical current **"ampere".**

1955

Founding of the **OIML** (International Organization of Legal Metrology).

First functional **atomic clock** with caesium.

1960

International System of Units **(SI).**

1967

Redefinition of the unit **"second"** based on the frequency of a transition in the caesium atom.

1971

The **"mole"** becomes a base unit of the SI.

1983

Redefinition of the **"metre"** unit using the speed of light in a vacuum.

2019

Revision of the International System of Units (SI). Redefinition of the unit "kilogram" based on a natural constant.

2025

150 years of the Metre Convention.

1978

Introduction of the International System of Units (SI) in Switzerland.

2019

Revision of the Einheitenverordnung (Ordinance on Units).

1967

Inauguration of the building in Wabern.

1977

Federal Office of Metrology (FOM).

2000

Swiss Federal Office of Metrology and Accreditation (METAS).

2001

Opening of the extension to the building.

2013

From federal office to institute: **Federal Institute of Metrology METAS.**

2018

With its **FoCS** (Fontaine Continue Suisse) **atomic clock,** METAS realises the unit of a second and contributes to universal time accuracy (UTC).

2022

First realisation of the kilogram using the METAS **watt balance (Kibble balance).**

Service

Ethanol analyses at METAS

Ethanol (chemical formula C_2H_5OH) is a widely used, strictly regulated raw material used in everything from the production of spirits and cosmetics to pharmaceuticals and chemicals. Precise analyses and certified qualities are required every day to ensure that imports and distribution run smoothly. And this is one of the core tasks of METAS.

Peter Rohrer

A vital activity being carried out in the background: ethanol analyses at the Federal Institute of Metrology METAS are performed daily and under extreme time pressure. Even before the first batch of distilled alcohol can be unloaded into interim storage, it must be clear exactly what it contains – with officially certified proof. Whether for Alcosuisse AG[1], Schweizer Zucker AG[2] or other importers: METAS not only provides analytical values, but also indirectly influences decisions on supply chains, customs tariffs and industrial production processes. This article shows how precision, time management and metrological expertise work together to achieve significant added value and maximum safety for the ethanol product.

Ethanol analyses in the “Analytics” team

In the “Analytics” team of the “Chemical tests and consultancy” technical field in the “Chemistry and Biology” department at METAS, the team leader and three laboratory technicians are responsible for chemical analyses, while two laboratory technicians are responsible for sensory testing of alcohol samples. The latter two also train the specialists who are then entrusted with the odour qualification of the types of ethanol to be tested (see section “Tasting”). In addition, two research associates from the department support the analysis team in creating and approving the certificates.

The ethanol analysis process

The ethanol analyses for Alcosuisse AG and Schweizer Zucker AG are an extremely time-critical and commercially important service provided by METAS. They are carried out every working day throughout the year, including between Christmas and New Year, in a tightly scheduled process.

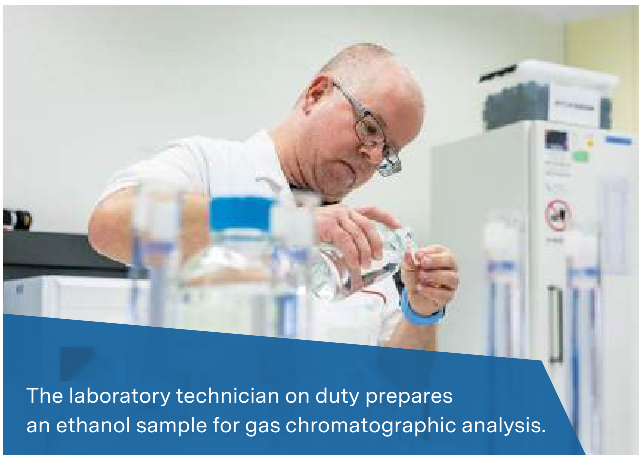
By 3 p.m. the day before, Alcosuisse AG or Schweizer Zucker AG in Aarberg will register the samples to be analysed the following day with METAS. This allows our analytical laboratory to prepare for the expected workload and complexity of the ordered analyses, which depend on the type and quantity of raw materials imported into Switzerland by the importers (mostly Alcosuisse).

On an average day, we receive around seven to eight analysis orders by post early in the morning, which usually consist of several 500 ml bottles of ethanol (all from the same batch).

After starting work, the laboratory technician on duty enters the samples in the system. Based on the information printed on the bottle, the system also records which of the approximately 250 different specifications (list of analysis types and sequences to be performed) should be used to test the sample. These may include chemical analyses of the ethanol content in the solution, the determination of denaturants or impurities in the ethanol; however, the customer may also request a so-called tasting (see section "Tasting").

Over the course of the morning, all analyses ordered (including tastings) are then processed, which can take several hours per sample depending on the complexity and scope of the specification(s). In order to ensure adherence to the tight time frame, it is crucial that the METAS specialists organise laboratory processes in an optimal manner in parallel.

All analysis results are then entered into the order-processing system to be checked for plausibility and correctness by a scientist responsible for approval. Once all values have been verified, the certificates can be approved and finally generated.



The laboratory technician on duty prepares an ethanol sample for gas chromatographic analysis.

This analysis and approval process must be completed by 12 noon and the electronically signed PDF certificates must be sent to the clients.

Why this time pressure? – A reminder: The ethanol containers delivered to the interim storage facilities are still sealed on the transport vehicles and are waiting to be emptied into the large storage tanks. The product cannot be accepted and transferred to the correct tank until the quality class of the delivered tank contents has been unequivocally determined and certified. The supply chain therefore comes to a standstill until METAS has completed its analysis.

Tasting

So you can get paid to drink schnapps at METAS with scientific backing?!

No, of course not! – In the case of pure ethanol samples from Alcosuisse AG or Schweizer Zucker AG, the so-called "tasting" (which should actually be called a "sensory test") is not a "classic" oral tasting. Instead, the testers use their sense of smell to determine how neutral and therefore how high-quality the alcohol sample is. To this end, the analytics team can draw on the finely calibrated senses of around fifteen specially trained METAS specialists, who are called upon as required for tastings.

In order to guarantee maximum objectivity and scientific accuracy, the laboratory technicians at the analysis laboratory prepare the samples to be tested anonymously so that the testers can then evaluate them independently and blindly. Each sample must be sniffed by at least three "noses" – but usually a few more – so that a representative average of the perceived odour levels can be calculated.

The samples are then classified according to the intensity of any undesirable odour perceived into one of five main quality levels "neutral", "very weak", "weak", "weak to distinct" and "distinct".

1 Alcosuisse AG was founded in 1998 as a profit centre of the former Swiss Alcohol Board, was privatised in 2018 and taken over by Thommen-Furler. Its headquarters are in Rüti bei Büren in the canton of Bern. Alcosuisse AG is the leading provider of ethanol in Switzerland. It supplies industry, the pharmaceutical and food sectors with around 500,000 hectolitres of high-quality ethanol products in over 50 different grades every year.

2 Schweizer Zucker AG, founded in 1997, processes Swiss sugar beet into sugar and by-products for industry and consumers at its plants in Aarberg (canton of Bern) and Frauenfeld (canton of Thurgau). The company was formed from the merger of the sugar factories in Aarberg (founded in 1899) and Frauenfeld (founded in 1903).

For comparison and to "calibrate" their sense of smell, the testers have access to appropriately calibrated odour references.

A classification of "neutral" means no foreign odour and represents the highest/best quality grade of ethanol, while "distinct" stands for the lowest/worst quality grade, i.e. the most distinct level of undesirable odour.

Tasting is carried out purely by smell, by comparing the samples to be tested with standardised references and then assigning them to the appropriate main quality levels.

Production of Swiss ethanol by Alcosuisse AG

Swiss ethanol of the highest quality for the spirits industry has been produced at the sugar factory in Aarberg (canton of Bern) since mid-2022. In collaboration with Schweizer Zucker AG, Alcosuisse AG has built a large distillation plant in Aarberg to produce ethanol from molasses, a by-product of sugar production.

The extremely high quality of the alcohol produced is achieved by means of a distillation column consisting of five columns, which exceeds the standard for comparable plants.

According to the schematic representation of the production process, the molasses is fermented in large tanks with the addition of water, sulphuric acid and yeast to produce a mash containing approximately 15% alcohol by volume, depending on the type of yeast used. In addition to technical alcohol (among others, methanol) and fusel oils, the desired ethanol of the highest quality class at 96% vol. is obtained by distillation. The remaining waste products are condensate, waste water and so-called black water, which must be disposed of.

The production of Swiss ethanol with the proper name "CH1" is purely seasonal, as it can only begin once the annual sugar production from sugar beet has been completed at the Schweizer Zucker AG factory in Aarberg; before that, no molasses is available. This is why it is continuously collected during sugar production and stored until it is mashed in the spring.

The five distillation columns for Swiss ethanol in the production hall of the sugar factory in Aarberg, Bern.

The following diagram shows the production of Swiss ethanol from molasses at Schweizer Zucker's Aarberg site.

Before the molasses was used to produce high-quality ethanol, this "waste" product from sugar production was simply disposed of. Alcosuisse AG and Schweizer Zucker AG have thus tapped into an intelligent new business area that also generates sustainable added value through the further processing of a potent raw material.

Links

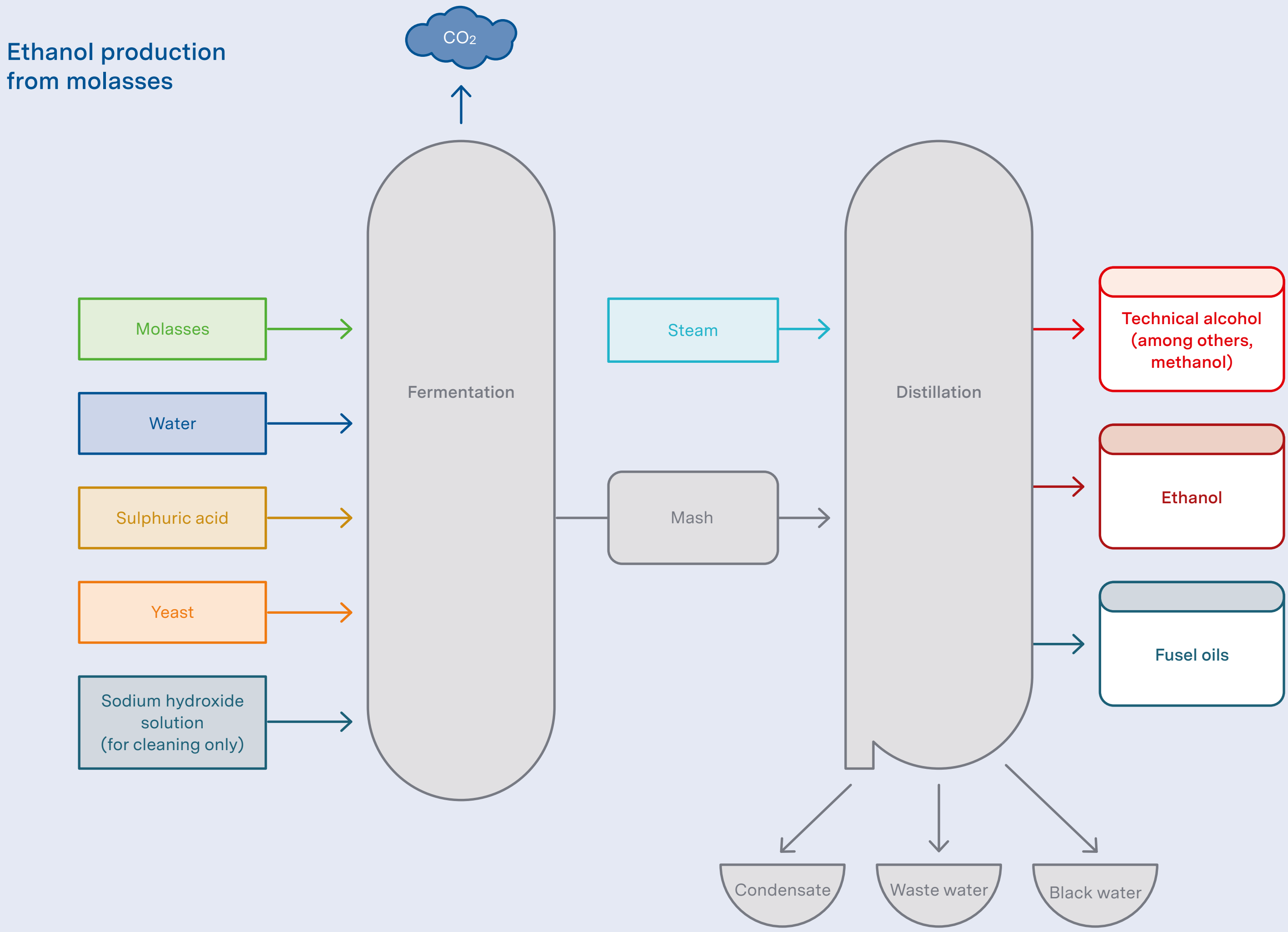
METAS, technical field "Chemical tests and consultancy": www.metas.ch/chem-pruefungen-beratungen

Alcosuisse AG: www.alcosuisse.ch

Swiss ethanol: www.schweizer-ethanol.ch

Schweizer Zucker AG: www.zucker.ch

Thommen-Furler AG: www.thommen-furler.ch/de



Importing alcohol into Switzerland

Alcohol has been a political issue virtually since time immemorial, since it generates considerable sums of money in the form of customs duties and taxes, which the state does not want to forego. For this reason, the classification of imported ethanol by an officially certified body such as METAS is of key importance.

Alcosuisse AG imports ethanol in various quality grades into Switzerland from abroad. The alcohol is delivered in containers sealed by the manufacturers to one of the two operating sites / intermediate storage facilities in Delémont in the Jura region or Schachen in Lucerne. Incidentally, since the massive increase in the demand for alcohol for disinfection purposes during the COVID-19 pandemic in 2020, the amount of pure alcohol required in our country has increased significantly.

The delivered ethanol containers must not be emptied directly into the storage tanks upon arrival at the interim storage facility, as this could result in different quality grades being mixed together; the ethanol must therefore first be analysed and officially certified by METAS. This is crucial not only in terms of the intended use of the raw material (as drinking ethanol, food-grade alcohol, ethanol for the chemical industry, for the pharmaceutical industry, for the perfumery industry, etc.), but also in terms of the customs tariff to be applied or the tax to be levied. So there is also a lot of money at stake, as the quality grade and intended use of the raw material can result in very different government levies being incurred. And this is precisely where the analysis and certification activities of METAS provide the decisive parameters.

Public health

For reliable measurements in nuclear medicine

Nuclear medicine patients receive injections of radioactive substances. In order to avoid high radiation levels that are harmful to their health or could cause the treatment to fail, the amount of substance used must be accurately measured. The METAS Ionising Radiation Laboratory helps ensure the quality of treatments by checking activity-measuring instruments and is involved in projects aimed at improving the traceability of measurements.

Dr Sándor Vörös

In nuclear medicine, different types of radionuclides (radioactive atoms) are injected into patients for diagnostic or therapeutic purposes (see insert 1). In order to determine the exact amount of substance to be used, the activity of the radioactive source is measured before each application to the patient using an *activimeter* (see inserts 2 and 3). Excessive activity would result in unnecessary radiation exposure to the patient, potentially endangering his/her health, while insufficient activity would compromise the effectiveness of the treatment or medical examination.

Quality assurance of activimeters

According to Swiss law, activimeters used in nuclear medicine have to meet various conditions[1] and be subject to strict quality assurance procedures[2]. One of the requirements is a three-year legal verification of the instrument, which METAS carries out on-site using long-lived radioactive reference sources: cobalt (Co-57 and Co-60), caesium (Cs-137) and strontium/yttrium (Sr-90/Y-90).

This verification, in combination with other types of checks such as the results of half-yearly linearity measurements and instrument maintenance, ensures the activimeter is functioning properly. However, it does not assess the accuracy of the *calibration coefficients* used by the instrument to determine the activity of individual radionuclides (see insert 3). These calibration coefficients are either provided by the activimeter manufacturer, determined after commissioning using a radionuclide reference source, or determined on-site by comparison with a transportable reference activimeter. The latter method offers the best traceability to the becquerel (Bq), but its implementation requires considerable effort.

Problematic radionuclides

Some radionuclides have properties which make it very difficult to determine their activity, as the values displayed by the activimeter can be influenced by different measurement parameters. These are in particular pure beta-emitting radionuclides such as lutetium (Lu-177) or yttrium (Y-90) or those that only emit low-energy gamma radiation such as iodine (I-123). Small geometric variations of the bottle or syringe containing the source or its position in the activimeter well can significantly distort the result. Only the use of calibration coefficients determined specifically for each of the geometries used can guarantee the required accuracy.

Measurements need to be improved

A study[3,4] conducted jointly by the Federal Institute of Metrology METAS, the Institute of Radiophysics of Lausanne (IRA) and the Federal Office of Public Health (FOPH) examined these influencing parameters and quantified the deviations that could affect the activity measurements of these "problematic" radionuclides. The study included extensive consultation with Swiss nuclear medicine centres to gain an overview of their practices in this area, on-site measurements in a few hospitals and a systematic study

What is nuclear medicine?

Nuclear medicine is the medical specialty that deals with the use of adioactive elements (radioactive isotopes) for the study, diagnosis and treatment of diseases affecting organs or tissues.

In the field of diagnostics, nuclear medicine provides two- or three-dimensional images, supplementing information obtained from radiology, ultrasound and magnetic resonance imaging (MRI). The two main detection systems are gamma scintigraphy and positron emission tomography (PET), usually complemented by computer-coupled X-ray imaging (CT). These allow medical professionals to obtain high-precision images of the heart muscle, lungs, thyroid, brain, etc. These images can be used to detect deep lesions or diseases at an early stage of development.

In the therapeutic field (metabolic or vectorised radiation therapy), a radioactive isotope is administered orally or by injection, which then attaches to the diseased target cells as designed. This technique can be used to treat benign conditions (e.g. hyperthyroidism) and malignant diseases (thyroid cancer, prostate cancer metastases, etc.).

PET-CT scanner (see insert 1).

What is radioactivity?

Radioactivity is the physical phenomenon by which unstable atomic nuclei (called radionuclides or radioisotopes) spontaneously transform into other atoms (decay), simultaneously emitting particles of matter (electrons, helium nuclei, neutrons, etc.) and energy (photons and kinetic energy). The emission of material and immaterial particles is called *radiation*, and the energy of the particles is sufficient to cause the ionisation of the matter they pass through, i.e. to break away electrons bound to the atoms of that matter, hence the name *ionising* radiation. Traditionally, a distinction is made between α rays consisting of helium nuclei (also called α particles), β rays consisting of electrons or positrons (β particles) and γ rays consisting of photons, to which neutrons from spontaneous fission must be added.[7]

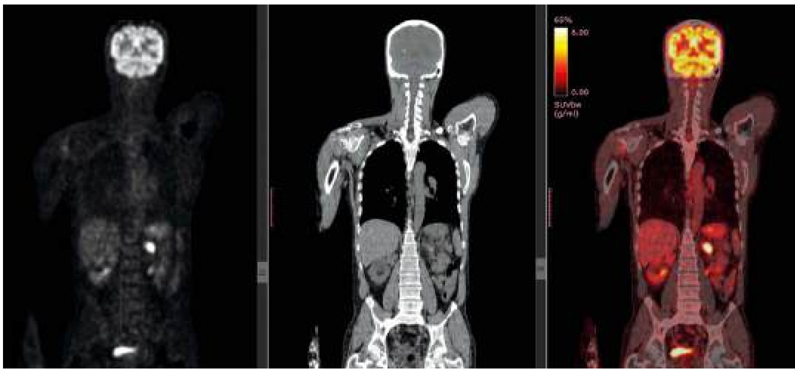
of the measurement deviations that can be expected in the METAS. Type C laboratory.[5] The IRA-METAS TCIR (transportable reference ionisation chamber) reference activimeter was used during the various phases of the project.

The results show sometimes significant discrepancies between the measured activities and the reference activities, up to several dozen per cent. The current revision of the Ordinance on Measuring Instruments for Ionising Radiation (IRMISO)[1] and the Directive on the Quality assurance of activimeters[2] will incorporate some of the findings of this study in order to improve the accuracy of activity measurements in nuclear medicine centres. In addition, a second reference activimeter, TCIR-II, will be built to increase on-site calibration capabilities and thus enable more reliable measurements in Swiss nuclear medicine centres.

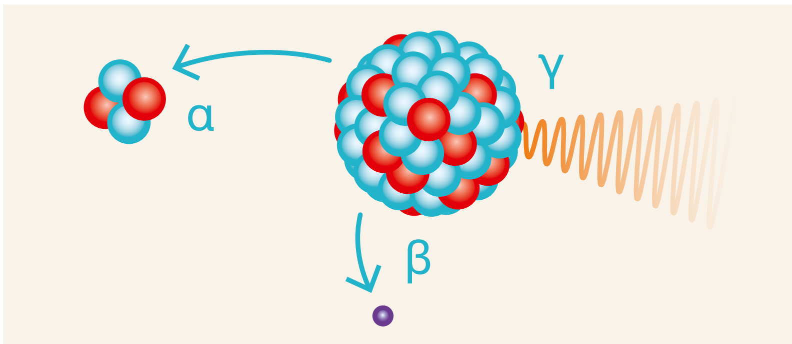
Development of international coordination

The metrological shortcomings identified in Switzerland are a common problem across Europe, where several million patients receive injections of radiopharmaceuticals every year. This situation stems in part from the origins of nuclear medicine as a qualitative or palliative technique, and leads to unsatisfactory treatment of pathologies and unsuccessful clinical trials. Furthermore, the lack of assessment of uncertainty in the dose administered to patients is also a critical barrier when taking traceable measurements (images and treatment outcome cannot be compared).

The European project ETrain[6] was launched in 2025 to remedy this situation. It aims to develop a network of calibration services for activimeters in all member countries of the European Association



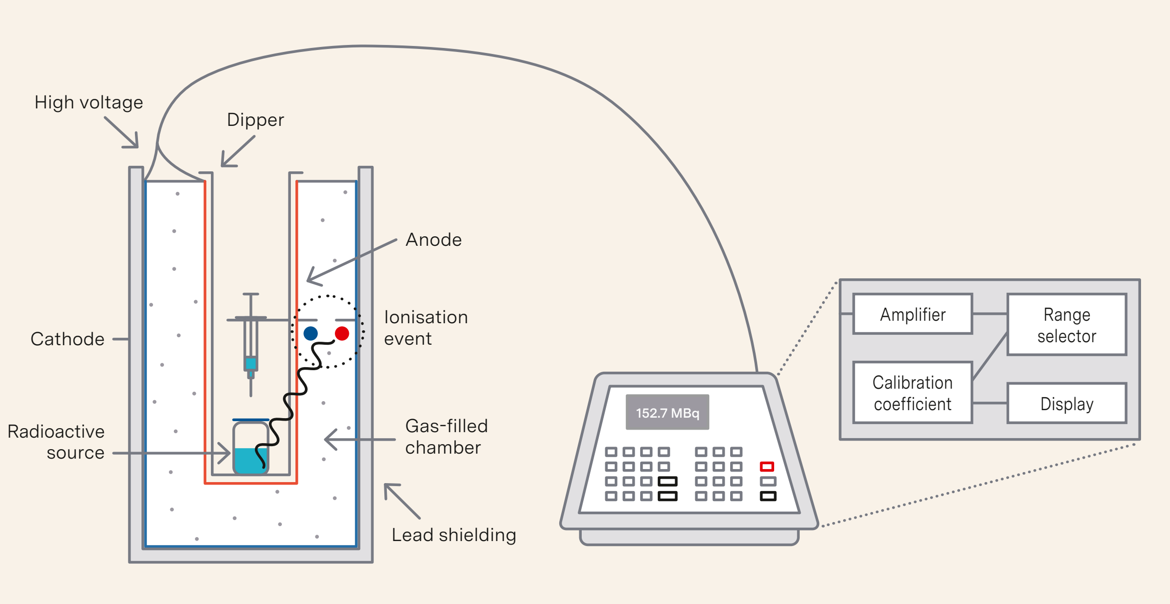
From left: PET image obtained using a radiotracer (revealing metabolic activity), X-ray CT image (revealing anatomy) and the combination of the two, providing a wealth of detail that enables highly effective detection of pathologies (see insert 1).



A radioactive atomic nucleus can decay by emitting α, β or γ radiation (see insert 2).

Measurement of the activity of a source

A radioactive source is characterised by its composition (the type of atoms it is made up of) and its activity (the number of atoms that decay per unit time). The activity depends on the total number of atoms and their period (also called half-life), which refers to the time it takes for half of the nuclei initially present to decay. In the International System of Units (SI), the activity of a source, i.e. the number of decays per second (s^{-1}), is expressed in becquerel (Bq). The instrument commonly used to measure it is called an activimeter. It usually takes the form of a well-type ionisation chamber consisting of two concentric cylinders between which a high-pressure gas is ionised by radiation emitted by the radioactive source placed in the centre. The ionisation charges thus released in the gas drift under the effect of high voltage to electrodes, where their current (in the nanoampere range) is measured by an electrometer. The activity of the source is evaluated by applying a radionuclide-specific calibration coefficient to the measured current value.



Schematic diagram of an activimeter (see insert 3).

of National Metrology Institutes (EURAMET), in order to establish the metrological traceability of activity measurements in nuclear medicine. METAS and the IRA are on hand to ensure that the knowledge and experience gained will also benefit patients at Swiss nuclear medicine centres.

1 FDJP Ordinance on Measuring Instruments for Ionising Radiation (IRMISO), SR 941.210.5, https://www.fedlex.admin.ch/eli/cc/2012/878/fr (currently under revision)

2 Federal Office of Public Health (FOPH), Quality assurance of activimeters, Directive L-09-01, https://backend.bag.admin.ch/fileservice/sdweb-docs-prod-bagadminch-files/files/2025/03/18/d21eb30e-8973-41a8-9dbc-4667e95afc28.pdf (currently under revision)

3 Investigation on calibration coefficients of dose calibrators and their influence on different geometries for beta- and gamma-emitters, https://backend.bag.admin.ch/fileservice/sdweb-docs-prod-bagadminch-files/files/2025/07/15/28a360d7-a7fe-42ff-b8e1-53cd79903451.pdf

4 S. Vörös et al., Investigation on calibration coefficients of dose calibrators and influence of different geometries for beta- and gamma-emitters, Physica Medica 125S1 (2024) S443, https://www.sciencedirect.com/science/article/pii/S1120179724009578

5 The Radiological Protection Ordinance [5] provides for architectural requirements to minimise the hazard by containing unsealed radioactive substances. Depending on the hazard and the quantity of radionuclides being handled, it may be necessary to use a laboratory with different types of equipment (e.g. shielded fume hoods with air filtration). Such a laboratory is designated by its type (A, B or C) depending on the level of safety required.

6 *Establishing traceability routes in nuclear medicine* (ETrain), 24RPT01

7 https://en.wikipedia.org/wiki/Radioactive_decay

Interview

New Domain Manager and new Head of Laboratory in the Physics department

Two new faces have appeared in the field of metrology in Physics II since this spring. Ulrich Schlapbach took over as Domain Manager on 1 January 2025. Philippe Chavanne started working as head of the Length, nano- and microtechnology laboratory two months later, in March. In this interview, they look back on the first few months and offer an outlook on the plans and challenges ahead.

Interview with Ulrich Schlapbach and Philippe Chavanne, conducted by Xavier Rappo

Ulrich Schlapbach and Philippe Chavanne, you joined METAS just a few months ago. What has made a particular impression on you?

Ulrich Schlapbach (left): I have noticed such a high level of expertise in a wide variety of fields. That's what has impressed me the most. What's more, people are really passionate about what they do. You can feel it and it's also such a positive thing!

Philippe Chavanne (right): I can only agree with that. The level is really very high. People's pride in their jobs is noticeable, and the culture is extremely positive: open, collaborative, but also challenging.

You both started in the same domain, two months apart. How is the collaboration between you two? Was it a challenge to bring so much "new blood" into the domain at once?

U.S.: Everything here was quite new to me. That's why, when Philippe started, I had to ask myself: What can he not know yet? Where else do I need to support him and where can I have opportunities to share our experiences as newcomers and find out how he experiences it?

P.C.: We embarked on a journey together to get to know and understand the world of metrology. In doing so, we'll undoubtedly ask one or two innocent questions and question the status quo – because we represent different characters and new perspectives.

What did you know about metrology before you joined METAS?

U.S.: I was relatively familiar with industrial measurement technology, and I have a lot of experience in this field. I have already learned a great deal about legal metrology. I wasn't familiar with this area and I'm sure there is still much to learn in fundamental metrology.

P.C.: I am familiar with metrology most of all from industry. For me, working at a national institute like METAS means a holistic approach. Here, we cover the entire range of services – from commercial calibrations and national approvals to international research and primary realisation. I find the opportunity to be involved in it an exciting challenge.

Philippe Chavanne took over as head of the Length, nano and micro-technology Laboratory in March 2025.

Do you both have a science background?

U.S.: Interestingly, my first job after studying electrical engineering at ETH was a position as a research assistant at this school. I worked in this role for almost two years before moving to work in industry at ABB. I held a number of very physics-related positions there, including 14 years in the semiconductor industry. In the last eight years before coming to METAS, I worked in the service department, where I developed new support services for clients.

P.C.: After studying life sciences at FHNW (University of Applied Sciences and Arts Northwestern Switzerland), my professional career also began in an academic environment. At that time, I had the opportunity to set up a research group on the additive manufacturing of biomaterials at the University. Mimedis AG was spun off from the activities at FHNW. This gave me the chance to get to know the world of start-ups. After that, I stayed in the medical technology sector and spent eight years in various research and development positions at Institut Straumann AG, a Swiss company specialising in the manufacture of instruments and components for dental surgery.

Ulrich Schlapbach has been Domain Manager of Metrology in Physics II since 1 January 2025.

From your point of view: What can METAS learn from industry and your experiences?

P.C.: In my case, it is certainly the experience gained in a highly regulated and innovation-friendly working environment. Even though metrology is regulated in a different way to medical technology, I am convinced that we can learn a lot from medical technology – in particular, how to implement effective quality management systems (QMS) that meet the highest quality and safety requirements while still leaving room for innovation.

U.S.: I think that METAS stands above all for very static optimisation that focuses on measuring accuracy and precision. In industry, on the other hand, you constantly have to make new, dynamic decisions. I think these two worlds have to have contact with each other. This is particularly true in view of its orientation as an institute that not only has to meet statutory requirements, but also has to generate a certain proportion of its turnover itself. In my opinion, connecting these two worlds without generating unresolvable conflicts is actually the most exciting challenge.

P.C.: In the area of conflict with its statutory duties, which are sometimes obligatory, it used to be the case that it was less important to pay attention to clients' needs – the client had to, was allowed to or was supposed to approach you. Nowadays, however, it is all the more important for a national institute to really focus on its clients, understand their needs and align its services optimally with them.

And why did you decide to work at METAS? What was your main motivation?

U.S.: It was a good time in my lifetime career as a whole to take my personal development one step further in the new environment. I had the impression that I could also put my experience and knowledge to productive use here. I'm 56 and I've been thinking about what else I would like to do in the coming years of my working life.

P.C.: For me, it was the urge to return to working in an organisation that thinks in the long term. I could find that here. I was also very impressed by the working culture. METAS is characterised by an open culture embodied by experts who take pride in their jobs. And last but not least, it feels like "coming home" to Bern. I grew up nearby and it's just nice to be able to work near Bern again.

What leadership style do you have? What values would you like to convey?

U.S.: For me, "goal-oriented" and "authentic" are clearly my key values. I really want to exemplify them and stand by them. I see myself as a leader and not as a manager. That's also important to me. A key point for me is that decisions are prepared soundly and then consistently implemented.

I try not to micromanage. I make sure that we work together and find the right time to say, "This is how we'll do it". But then it should be done that way. This must be understandable to employees. Not everyone has to agree, but everyone needs to understand, that's what I think is most important.

P.C.: I tend to have a democratic leadership style and I want to encourage people to take responsibility. An open yet controlled error culture is important to me. At METAS, I see a lot of potential in the technical personnel and experts in particular, which we should support. I also promote a decision-making culture in which objective decision-makers make well-founded decisions and implement them consistently.

Let’s take a look back. What have you done in the first few months? Have you experienced any personal challenges?

U.S.: I’ve actually focused on actively getting to know people first. I wanted to understand the roles and responsibilities. How do the processes, the METAS “machinery” and the areas of conflict work? Where are things not working the way we want or the way we think they are?

P.C.: It was very similar for me. First, I had to read the materials, build a network, get to know the people and then start the analyses. I needed to understand the situation, the lab and the department. And finally, recommend the first principles of lean management.

Where do you see the biggest challenges in your new roles at the moment?

U.S.: The main task for me is to develop the strategy for the department with a view to its orientation for 2030, i.e. for the coming years. What direction will we choose for the future and where do we position ourselves so as to have a sound foundation?

P.C.: For me, the major challenge is to find the right balance between calibration services and research in the lab. My aim is to ensure that the laboratory remains at the forefront of the metrology field and remains economically successful in the future through targeted research and development activities. It is particularly important to get employees on board and involve them on this journey.

What are your priorities or goals for the next six months?

P.C.: I had a clear goal: the audit of our laboratory by the Austrian National Metrology Institute in June. The laboratory analysis – i.e. a better understanding of personnel, finances, measuring stations and their life cycles – is to be completed in order to record the current situation and identify potential for optimisation. Based on this, a new mission will be developed that will be incorporated into the domain strategy.

U.S.: For me, it’s developing the strategy in interaction with the various laboratories, domains, the division manager and the management team.

Do you have a word or image that summarises the first few months?

U.S.: I particularly remember the amazement and admiration in the eyes of the visitors who come here and take a guided tour through the labs. That’s actually the same positive impression I have, too. At the beginning, visitors have no real idea what to expect and immerse themselves in the world of metrology and the laboratories. There’s no chance of getting bored, because the next surprise is always waiting.

P.C.: For a variety of reasons, a mountainous backdrop suits me very well. You stand in front of a wall and go on a personal learning curve. That’s exactly what metrology is for me right now. At a National Metrology Institute (NMI) like METAS, you are at the top of the traceability chains, so to speak, and have the necessary vision. At the same time, METAS has some absolute experts who can delve into the deepest valleys of basic metrological research. You go through this vertical movement all the time.

In brief

2024 annual report on the implementation of the Metrology Act

In 2024, more than 175,000 measuring instruments were tested and calibrated as part of the inspections for the implementation of the Metrology Act. More than 740,000 electricity meters were statistically monitored. In addition to METAS, the cantonal supervisory authorities, the cantonal verification offices and the verification laboratories authorised by METAS are involved in the implementation. More detailed information can be found in the 2024 annual report on the implementation of the Metrology Act.

Link to the report (only available in German and French):
https://www.metas.ch/dam/metas/de/data/dokumentation/metas-publikationen/berichte/jahresbericht_vollzug_messgesetz/jahresbericht-2024-d.pdf.download.pdf/jahresbericht-2024-d.pdf

New Head of Chemical Tests and Consultancy department

On 1 August 2025, Dr Gisela Umbricht took over as Head of Chemical Tests and Consultancy (CPB) from Dr Markus Stadler, who is taking early retirement. Dr Umbricht holds a doctorate in chemistry and gained her first managerial experience in the industry after completing a postdoc at Colorado State University. After several years as head of an organisational unit at the Directorate General of Customs, she moved to METAS. As a laboratory manager at METAS, she successfully established two laboratories before taking up her new role.

Swiss Youth in Science: special prize metrology 2025

METAS is sponsoring the special prize for metrology as part of the national competition “Schweizer Jugend forscht” (“Swiss Youth in Science”). This year, three prize winners were honoured.

In her work, Franziska Fehr investigated the psychological well-being of adolescents. Based on a WHO scale, she found that their well-being was fairly moderate.

Aurélien Jacot investigated how drones can be used to measure wind speed. To do this, he had to take all relevant influencing factors into account and verify his model with measurements.

Laurin Seeholzer also developed a simulation model. His surface temperature model depends largely on the quality of the input parameters.

These award-winning projects from a variety of fields demonstrate the importance of measurement in research.

New protocol for preparing food samples for titanium dioxide analysis

Titanium dioxide (TiO_2) was classified by the European Food Safety Authority as no longer safe for use in food in 2021. Switzerland also followed suit after this decision. The substance partly exists in the form of nanoparticles and was previously used, among other things, as a dye (known as E171) in confectionery. A newly developed protocol for sample preparation enables safe and efficient analysis of TiO_2, eliminating the use of hazardous chemicals while simplifying the analytical process at the same time. This paper was published in an application report in collaboration with the company Anton Paar.

Link to the report:
https://www.anton-paar.com/corp-en/services-support/document-finder/application-reports/towards-a-safe-and-efficient-digestion-of-tio2-nanoparticles-in-confectioneries-using-hbf4/

Memorandum of Understanding signed with the School of Biomedical and Precision Engineering (SBPE) at the University of Bern

In January 2025, the Federal Institute of Metrology METAS and the School of Biomedical and Precision Engineering (SBPE) at the University of Bern signed a Memorandum of Understanding (MoU) in Bern. Under the MoU, the collaboration in research and education in the fields of precision engineering and metrology will be strengthened. Each institution can benefit from the technical and scientific infrastructure and specific expertise of the other. Regular exchanges will be maintained through joint seminars, colloquia, and workshops.

Full release:
https://www.metas.ch/metas/en/home/dok/publikationen/meldungen/mou_metas_sbpe.html

METAS at World Expo 2025 in Osaka

At World Expo 2025 in Osaka (Japan), the Federal Institute of Metrology METAS and the Federal Office of Meteorology and Climatology MeteoSwiss presented the latest advances in pollen information in collaboration with Swisens AG. The exhibition stand in the Swiss pavilion showcased the latest developments as well as the real-time pollen load measured at the National Metrology Institute of Japan (NMIJ) in Tsukuba. Out of over 70 domestic applications, the METAS and MeteoSwiss team was ultimately selected as one of only seven Swiss exhibitors within the "Life" (Life Sciences, Education, Health and Nutrition) section of the exhibition. Together, we had the opportunity to represent Switzerland and our Swiss identity in Japan from 11 June to 12 August 2025.

Success for the Flow Laboratory at the IMEKO conference

Following the participation of the Flow Laboratory at the IMEKO conference in Hamburg, the laboratory's three presentations "Comparison of primary standards for liquid flow in the range from 0.1 µL/min to 10 µL/min", "Dimensional calibration of small critical flow Venturi nozzles" and "Comparison of gravimetric standards for hydrogen refuelling stations" were published in the journal "Measurement: Sensors" in May. This peer-reviewed journal is overseen by the International Measurement Confederation (IMEKO). It is a reference for publications in the field of measurement techniques.

Links to publications:

Dimensional calibration of small critical flow Venturi nozzles

Comparison of primary standards for liquid flow in the range from 0.1 µL/min to 10 µL/min

Comparison of gravimetric standards for hydrogen refuelling stations

About METAS

Enhanced security: two-factor authentication on the METAS web platform

Greater security for your certificates: with the new METAS web platform and the introduction of two-factor authentication (2FA), METAS is protecting sensitive customer data – while at the same time laying the foundations for a modern, digital user experience.

Peter Rohrer

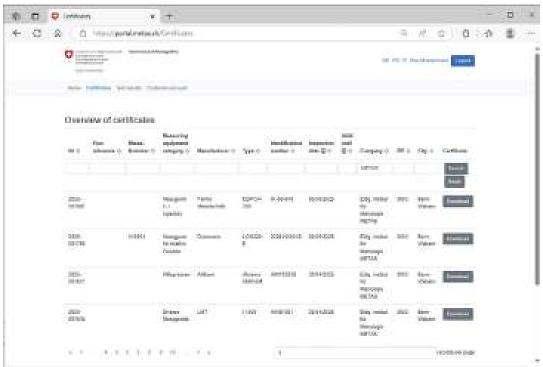
In order to meet the increasing requirements in terms of data security and user-friendliness, the Federal Institute of Metrology METAS launched the new METAS web platform (https://portal.metas.ch) on 8 April 2025. This enables clients to access and download their calibration and test certificates online quickly and securely.

Logging in using a username and password alone no longer fulfils today's security standards. If this combination falls into the wrong hands – for example through unintentional disclosure, spying or hacking –, it is almost impossible to prevent misuse (see box "Two-factor authentication: more secure access").

Next step towards the client portal: new order processing system introduced

A new order processing system was also introduced at the beginning of April. This state-of-the-art, secure and flexible solution made it possible to optimise and automate internal processes.

At the same time, this marks a further milestone on the way to a fully fledged digital customer portal – with the aim of making access to services and information even more efficient and user-friendly in the future.



Clients can find all their certificates in the certificate overview. The displayed documents can be filtered by a variety of criteria and downloaded as required.

Secure login using 2FA

In the past, our clients received their certificates via an email link; this meant that anyone with access to the link could download the document, and certificate recipients had to manage their documents themselves. Now, the secure METAS web platform only grants access to authenticated clients.

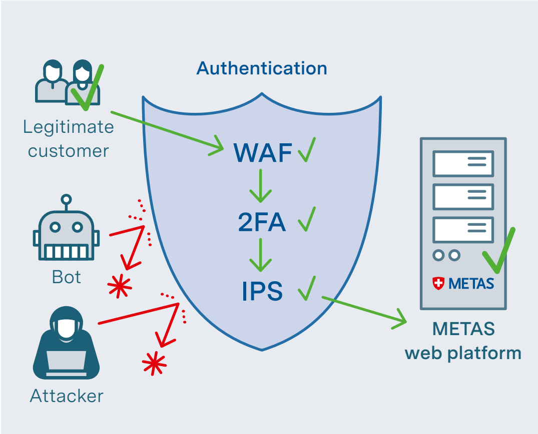
After entering the user name and password, a one-time code will be emailed to the address stored in the client account. This two-factor authentication (2FA) significantly increases security.

Although, at first glance, this may seem to complicate the previously simpler certificate delivery procedure, 2FA greatly increases the security of access to client accounts (see interview "The CISO explains it in a nutshell").

Through the new METAS web platform, METAS offers its certificate recipients clear, reliably secured, traceable and expandable access to their digitally signed documents.

Two-factor authentication: more secure access

Two-factor authentication (2FA) increases security when logging into web applications by combining a user name and password with a second factor (e.g. a one-time code via email, SMS or authentication app). This means that access remains protected even if a password is stolen.



Only authorised users can make it through authentication right down to the web server. Bots and other attackers fail due to the web application firewall (WAF), the 2FA and/or the intrusion prevention system (IPS).

The CISO explains it in a nutshell

The Chief Security Officer (CISO) of METAS, Daniel Lussi, provides some in-depth insights into the issue of cybersecurity on the new METAS web platform.

Why was the mechanism of the certificate download changed?

Daniel Lussi: With the previous download link alone, it was not possible to verify the identity of the certificate recipient, whereas the new login with 2FA now guarantees this. However, METAS is responsible for ensuring that the certificates reach the right client.

And the new system now offers this improved security?

Yes. The system is effectively protected against cyberattacks by a login architecture consisting of a user name and password, plus the one-time code by email – the mechanism is called two-factor authentication (2FA) – and supplemented by a web application firewall (WAF) and an intrusion prevention system (IPS).

Is this the peak of possible cybersecurity?

Security is not an end point, but a process, as cyberattacks and threats are constantly evolving. METAS is therefore continuously working to strengthen all of its externally accessible web services.

Did you know?

The stele has a ground plan of 60 cm × 60 cm and a height of 24 metres. It thus embodies the division of time, or more precisely, the day, which consists of 24 hours of 60 minutes of 60 seconds.

It is made of chrome steel and is gold-plated. It is the work of the Aargau artist Max Matter (1941).

More information:
www.metas.ch/stele-en

METAS
Your reference.

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