



Annual Report 2006



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METAS, the National Metrology Institute of Switzerland

The Federal Office of Metrology (METAS) in Bern-Wabern maintains the national measurement standards of Switzerland, ensures their international recognition and disseminates them with sufficient accuracy to Switzerland's research, economy and society. METAS takes the necessary steps to ensure that the measurements required for the market as well as for the protection and safety of the population and the environment can be made correctly and in compliance with the applicable laws and regulations. METAS has been a FLAG entity since 1999: The Management with Performance Mandate and Global Budget (FLAG) orientates state-owned operations to measurable performance and impact (www.flag.admin.ch).

Cover Illustration

Dr Wolfgang Schwitz, Director of METAS, says goodbye to State Secretary Charles Kleiber from the State Secretariat for Education and Research (left). At the centre of his visit to METAS stood the development of a European metrology research programme, research in the field of time and frequency measurement and the tour of METAS laboratories.



Dear reader

Legal metrology in Switzerland has been newly-regulated since 30 October 2006. On that date, new directives applicable to this field came into effect. The completely revised regulations take into account technical, economical and social advances and translate Switzerland's bilateral agreement with the European Community on mutual recognition of conformity assessments in the scope of measuring instruments and pre-packaged goods. This consequently simplifies the placing on the market of measuring instruments, as is illustrated in the chapter on the product group Legal Metrology.

In order to be able to consider this new procedure for placing on the market and the legal mandate, METAS has established its own conformity assessment body. A federal coordination organ has likewise been set up, which is to be allocated responsibility for the scope of measuring instruments.

Reliable measurements play a role not only in trade and industry, but also in public health. In the fields of medicine, chemistry and biotechnology, the traceability of measurement results to internationally recognised measurement standards is often still unfeasible. METAS partakes in the endeavours to improve this situation. Accordingly, it is currently involved in a joint project with the Paul Scherrer Institute (PSI) to develop a reference mass for the dosimetry of proton rays. This is to enable a more accurate measurement of the therapy dosage of proton radiation, a new and very promising form of radiation therapy. METAS has also commenced the development of a laboratory for electrochemical analysis, in which two facilities for clinically-relevant measurement quantities are shortly to be installed. More detailed information is included in the chapter on the product group National Standards.

The reliability of measurements depends, on the one hand, on qualitatively flawless measuring instruments, which are traceable to internationally recognised reference standards. On the other hand, the operating and handling of the measuring instruments is decisive. This was also revealed by the survey on customer satisfaction, which METAS carried out last autumn. The customers awarded the METAS staff the highest appraisal in all quality dimensions, as can be read on page 5.

The chapter on the product group Industrial Metrology includes a review of the new and improved measuring facilities at METAS. It clearly signals that METAS strives to continuously inspect and adapt its services in order to be able to provide research, industry and society in due time with the required metrological bases and measurement services.

Yours sincerely

A handwritten signature in blue ink, which appears to read 'W. Schwitz'. The signature is fluid and cursive.

Dr Wolfgang Schwitz
Director

World-wide Recognition of Measurements and Tests

Internationally recognised measurement results and conformity assessments constitute basic prerequisites for society and economy in today's industrial nations. With the operation and further development of the national measurement system and its international linkage, METAS safeguards Switzerland's connection to a global network of metrology and conformity assessment.

One of the important demands placed by the market is that a single measurement or test carried out on a product is sufficient for world-wide recognition. In order to achieve this aim, measurements are to be objective, clear, reliable, sufficiently accurate and comparable, which dictates the existence of a universally applicable reference system. It also requires international agreements to establish the procedure for crossborder recognition of measurement results.

World-wide Standardised Measurements

The International System of Units (Système international d'unités, SI) forms the basis for world-wide standardised measurements. The foundation was laid in 1875 with the signing of the International Metre Convention. Today, the convention comprises 51 member states and 21 associated members and the SI has been legally introduced in all industrial nations. The Metre Convention organs ensure that the SI continues to develop in accordance with the users' needs. The mission of the national metrology institutes (NMI), in Switzerland METAS, is the realisation, conservation and dissemination of the SI units and national standards to the appropriate accuracy needed in each country. This is an infrastructural task of public interest, which in the majority of countries is therefore managed by staterun institutes.



International Recognition of National Standards and Certificates

The realisation of the measurement units on a national level in the form of national standards (metrological standards at the highest level) is not enough. In addition, the national standards and the NMI's calibration and measurement certificates based on these standards need to be internationally recognised. This is why a multilateral agreement (MRA) was signed in 1999. The MRA is meant to collect evidence and to formalise the procedures that establish the equivalence and the mutual recognition between the national standards of the participating countries, between the calibration and measuring capabilities of the NMI's and between the traceability chains that link the calibration and testing services to the national standards in each country.



The equivalence of national standards can only be proven by extensive international measurement comparisons. Consequently, the metrological basis of the MRA is formed by the so-called *key comparisons*. The key comparisons are a system of international measurement campaigns that allows the systematic testing of the most significant calibration methods in order to make calibration results comparable between all NMIs. Organisation, procedure and analysis of the comparison results have to satisfy a series of clearly defined rules.

In addition to the successful participation to *key comparisons*, the NMIs are required to operate quality management systems that are mutually recognised within the framework of the MRA. On one hand, the quality system is necessary to guarantee the traceability of the measurements and of the calibrations to the national standards and to the SI. On the other hand, the quality system is also necessary to define and to supervise the calibration and the measurement services that the NMI delivers to its customers.

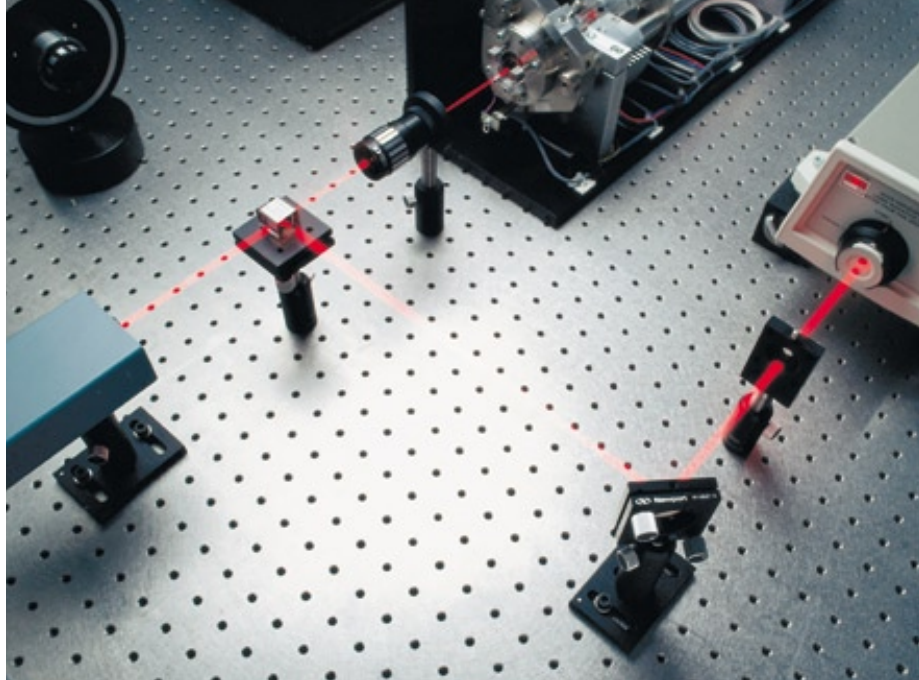
In the seven years since the signing of the agreement, the MRA has proved to be an astonishing success. 547 *key comparisons* and 138 *supplementary comparisons* were performed to establish the equivalence of the national standards and the measurement capabilities of the participants on an international level. Within the framework of the MRA, METAS has already taken part in 79 *key comparisons* (proportion 14 %) and in 35 *supplementary comparisons* (proportion 25 %).

The immediate result of the processes defined by the MRA are the *Calibration and Measurement Capabilities, CMC*, internationally approved for each participating NMI, which are stored in a data bank by the *International Office of Weights and Measures (BIPM)* and published on <http://kcdb.bipm.org>. Around 18 500 CMC, of which 323 from METAS, are already registered in this data base. Today, 180 NMIs and notified bodies from 65 countries mutually recognise across national borders the calibration and measurement certificates, prepared and published within the framework of the MRA.

The Principle of Traceability

The MRA has established a system of mutual recognition at the NMI level, which is based on a solid technical foundation and on mutual trust. Industrial users can therefore rely on a reliable metrological system. The traceability to national standards and to the SI is sufficient for the international recognition of any measurement result. The traceability of a measurement implies an uninterrupted calibration chain starting from the measuring instrument used in the industry and going up to the national standard maintained by the NMI and approved by the MRA. The individual calibration steps involved along the traceability chain are to be performed by recognised bodies in compliance with standardised procedures.

International Networking



International Recognition of Test Reports

Tests for the certification of measuring instruments are carried out in accordance with metrological requirements which are specified in international standards or recommendations; these standards and recommendations are also based on the SI and thus on the national standards and on the measurement capabilities of a NMI.

Examples for this are load cells, which are important metrological elements for scales and weighing instruments. In this field, METAS signed in 2006 the so called *Declaration of Mutual Confidence (DoMC)* of the *Mutual Acceptance Arrangement (MAA) on Type Evaluation* of the *International Organisation of Legal Metrology (OIML)*.

The aim of this agreement is the formal recognition of test reports that are provided with an OIML conformity certificate. The signatories of the DoMC commit themselves to unconditionally recognise the certificates issued under the MAA for all categories of measuring instruments. This agreement offers the significant advantage that the test results of the OIML-MAA-recognised issuing authorities are internationally valid. This avoids costly duplicated testing.

Conformity Assessments in Switzerland and Europe

The international recognition guaranteed by the MAA system of the OIML is not absolutely essential for manufacturers whose major markets lie in Switzerland and Europe. Measuring instruments compliant with new Swiss ordinances on measuring instruments can, thanks to harmonised conformity assessment procedure in Switzerland and throughout Europe, be placed directly on the market (see chapter *Conformity Assessment: Success in European Competition* on page 8). Owing to the bilateral agreements, the conformity assessments carried out by notified bodies in Switzerland for numerous categories of measuring instruments are valid for the whole of Europe, and vice versa.

In order to safeguard the international recognition of its standards, METAS has for many years participated successfully in international measurement comparisons. During one such key comparison between the International Office of Weights and Measures (BIPM) in Paris and METAS it was proven that the two primary laser standards for length measurement were consistent within the declared measurement uncertainty.

Great Satisfaction with the Services

Customer satisfaction with the METAS services remains very highly rated. This is demonstrated by the customer survey, which was carried out for the third time in 2006. The challenge now is to maintain this high standard.

Every couple of years, METAS ascertains the satisfaction of its customers with performed services. An independent firm carried out the last survey in September 2006. In order to gain as genuine answers as possible, the questionnaires were submitted anonymously. They were sent to all customers that had made use of a METAS service during the previous three years.

Above-average Members of Staff

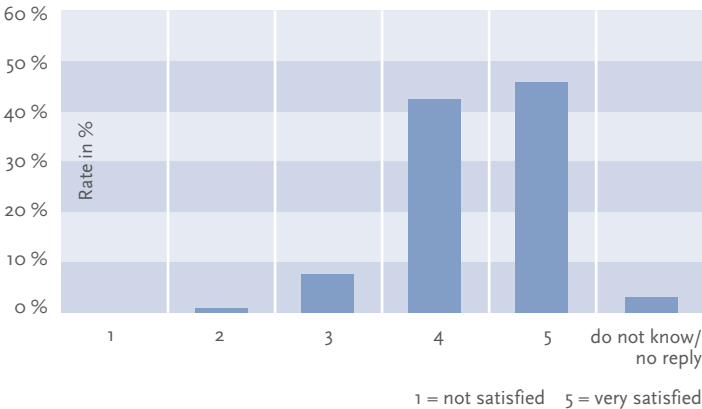
As with earlier surveys, the satisfaction is of a high level. The total satisfaction amounts to 4.37 on a scale of five. The members of staff attained, with a clearly aboveaverage note of 4.66, the highest appraisal of all the quality factors raised. Unsurprisingly, the cost-benefit ratio is again rated more critically here, with 3.78. Customers see potential for improvement in the amount and detail of the information supplied.

The Website is currently undergoing revision. The contents are to be streamlined and the navigation will be simplified. This is an initial step to improve the supply of information. Prompt and concise information, orientated to customer needs, are further characteristics that are to be paid greater consideration in the future.

Maintaining the Quality Level

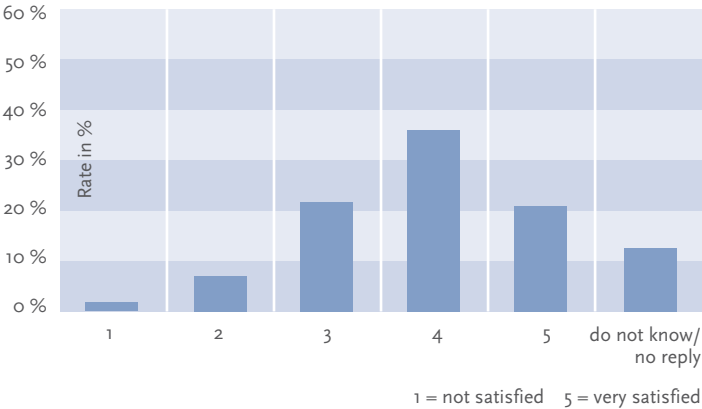
Outstanding services can only be rendered by the staff, when performance motivation and mutual respect are also cultivated in their professional surroundings. Upholding the high customer satisfaction shall remain a challenge to the management.

Total Satisfaction



The high rating of 4.37 on a scale of five shows that the customers are outstandingly satisfied with the services at METAS.

Cost-benefit ratio



Unsurprisingly, the cost-benefit ratio is rated critically: The average here is 3.78, whereby great discrepancies are determined between the various client groups.

Metrology in the Service to Health

Reliable measurements and standardised results in medicine improve diagnostics and therapies, and contribute to the reduction of health costs. METAS is extending its field of activity in order to improve the traceability of medical measurements to recognised standards.

In the year under review important upgrades were carried out in areas relevant to health.

Therapeutical Dosimetry Further Improved

Ionising radiation is used in hospitals and therapeutic centres for curing or for reducing pain in tumour patients. The highest possible dose (SI unit gray = joule/kg) of ionising radiation is deposited in the tumour to destroy malignant cells. At the same time it is important to preserve the surrounding healthy tissue as much as possible. The dose to be administered to the patient must be accurate and reproducible.

The Radiation Protection Regulation issued by the Federal Council of Switzerland requires that the reference measuring systems used for checking the radiotherapy units be calibrated regularly by METAS or by an agency recognised by METAS, and checked for their proper functionality.

METAS has facilities for the reliable verification of dosimeters. An electron accelerator (for highenergy electron and photon radiation) and a Cobalt-60 Gamma source are used to generate the ionising radiation. The therapy dosimeters submitted to verification by hospitals are exposed to the radiation beam from these sources under accurately defined conditions and their displays are compared with those of a transfer dosimeter.

For the determination of the absolute deposited dose in gray, METAS has two primary standards, i. e. standards designed for a calculable accuracy. Regular participation to international metrological comparison campaigns also ensures the traceability to the internationally supported realisation of the dose unit.

A promising new form of radiotherapy is the proton therapy to which the Paul Scherrer Institute (PSI) in Switzerland has made a significant contribution as a codeveloper. Narrow proton beams, as they are produced in the accelerator of the PSI, yield a better spatial control of the dose deposited in tumours.

The dosimetry of proton beams is not yet standardised internationally. In a joint project, METAS and the PSI are developing a primary standard based on a water calorimeter. Such an instrument measures the absorbed doses directly using the rise in temperature of the water exposed to radiation, water being a good simulator of human tissue. In December 2006, the first experimental measurements were conducted at the PSI with a prototype of the METAS calorimeter. The first results confirm that the selected approach is promising.

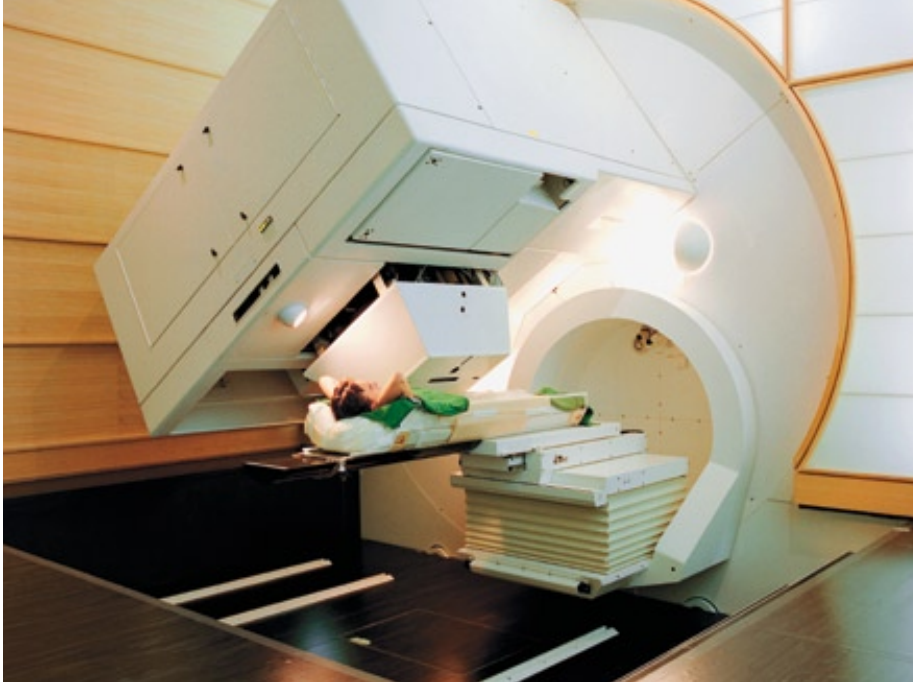
New Laboratory for Electrochemistry

In chemistry, biotechnology and laboratory medicine, the traceability of the measurement results to international standards is often not possible. Measurements performed in different locations or based on different methods are difficult to compare. Erroneous measurements, superfluous measurements or technical trade barriers often occur as a consequence to this lack of standardisation.

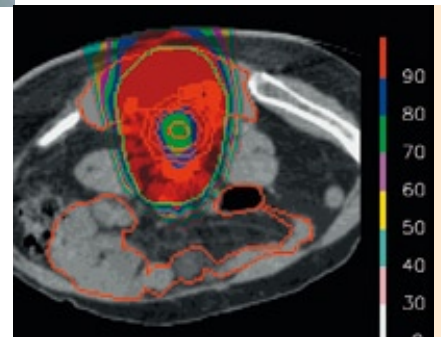
Efforts are in progress world-wide to improve the situation. METAS has decided to be active in the field of electrochemical analytics because the Swiss industry is very active in this area in research and development as well as on an industrial level.

With electrochemical methods, it is possible to determine, for example, the activities of clinically relevant substances such as sodium, potassium, magnesium, calcium or glucose present in the blood. Even the activities of nitrate, nitrite or ammonium in water can be measured successfully. The knowledge of the activity of substances in solution is important for the understanding of the meta-





In a joint project, the Federal Office of Metrology (METAS) and the Paul Scherrer Institute (PSI) evaluate the application of the water calorimeter as a primary standard for the dosimetry of proton radiation.



bolism of vegetation and for the quality control of water. The measured activity of a substance in solution characterises both the activity and the concentration of the substance. The measurement of activity thus goes one step further than a mere concentration measurement.

As a first step, two measuring systems for the measurement of clinically relevant quantities were constructed in the laboratory for electrochemistry. In a further step, evidence of the equivalence between measurements of the same quantity performed in different reference laboratories must be collected and critically analysed before an international recognition of the equivalence of such measurements can be established for a given quantity. After final characterisation, electrochemical sensors and measuring instruments relevant to the qualified quantity can be calibrated using the newly established standard.

Internationally Recognised National Standards

The objective of the product group *National Standards* is to maintain the basis necessary for a dependable measurement and test infrastructure in Switzerland. This effort takes place by the realisation and the dissemination of SI units. It also requires inhouse research and development, which are necessary both to keep pace with and to support the new technological developments. METAS researchers present their work at various international conferences and publish numerous scientific papers (pages 20 to 24 and www.metas.ch/publications).

A system of international measurement comparisons at the highest level constitutes the technical basis for the international agreement of 1999 that establishes the mutual recognition of national standards and calibration certificates (MRA). In the year under review, METAS successfully participated to 24 such international comparisons in various fields. Details regarding international comparisons and the METAS results are published regularly in METinfo, the Journal of Metrology, which can be subscribed to free of charge from METAS.

A comprehensive compilation of all international comparisons carried out in the context of the MRA and their results can be found at <http://kcdb.bipm.org>. The calibration and measurement capabilities of the national metrology institutes which participate to the MRA are also published in the same database. At the end of 2006, the database had 323 entries from METAS.

At a European level, METAS has collaborated to a project related to the transnational coordination of the metrological research and development, which aims at a significant increase of the efficiency of European metrology. As a result, the European Metrology Research Programme (EMRP) is planned to be launched in 2007 with the 7th Framework Programme for Research and Development (FP7) of the European Union, which is also open to Switzerland.

Conformity Assessment: Success in European Competition

On 30 October 2006, the adaptation of the Swiss regulations on measuring instruments to meet those of the EU enabled METAS to reap the fruits of many years of labour. The expansion of the bilateral agreement with the new ordinances on measuring instruments is a sweeping success for Swiss trade and industry.

The new conformity assessment body *METAS-Cert* certified the quality systems of several Swiss measuring instrument manufacturers, which, for the first time, enabled a broad range of instruments to access both the Swiss and European market simultaneously.

Legislation

On 30 October 2006, the EC Measuring Instruments Directive 2004/22/EC (MID) came into effect together with all the completely revised Swiss ordinances on legal metrology. These ordinances were adopted, equal to European legislation, in the bilateral agreement on the mutual recognition in relation to conformity assessment (technical barriers to trade) in the scopes of measuring instruments and prepackaged goods, and regulate the placing on the market and controlling of measurement stability in eight categories of measuring instruments.

The consequences of this revision and therewith the equality of Swiss and European law is of great significance. Essential requirements such as maximum permissible errors, reference conditions and the possible procedures of placing on the market of the various instrument categories were harmonised with the specifications of the new European Measuring Instruments Directive. As a result, one single conformity certificate is now adequate – regardless of whether it was issued in accordance with Swiss or European law. This is applicable to the following eight scopes: measuring instruments for thermal energy; material measures; dimensional measuring instruments; measuring instruments for liquids other than water; automatic and nonautomatic weighing instruments; gas meters; exhaust gas analysers for combustion engines and measuring instruments for electrical energy and power. All affected circles were orientated and provided with detailed information on this revision and the simplification, so essential to Swiss industry and Swiss economy.

Furthermore, Switzerland and the EC signed an agreement in Brussels on 22 December 2006 on a revision of the bilateral agreement of 1999 on the mutual recognition in relation to conformity assessment. This amendment, which took effect on 1 February 2007, omits, among other things, the clause on origin initially specified by the agreement, which limited the scope of the agreement to the originating products of the contracting party.

National Coordination

As provided for by the new Swiss measuring instrument ordinance, a coordination body was established and commenced its work during the year of report. This consultative organ shall assist and support the federal authorities with the revision, harmonisation and the maximum possible simplification of the regulations on measurement procedures and instruments for application in trade, public health, environmental protection, public safety and the official ascertainment of facts. The existing regulations are currently being compiled. The instrument categories, for which new specific metrological requirements are planned, shall be presented to the organ for consultation.

The transfer of information, co-operation and mutual understanding between all agents involved in regulated measuring instruments are central elements for the best possible integration and realistic consideration of the new measuring instrument ordinance requirements.

International Co-operation

International co-operation has always played an essential role in legal metrology. It serves, in particular, the transfer of information for the harmonisation of conformity assessment and test procedures, the consolidation of market surveillance and the mutual recognition of test results and certificates (see chapter *World-wide Recognition of Measurements and Tests* on page 2).

To this purpose various METAS experts regularly attend the technical meetings of the *International Organisation of Legal Metrology (OIML)* or the *European Cooperation in Legal Metrology (WELMEC)* and actively participate with their statements in the establishment or revision of standards, recommendations, documents or guidelines.



The co-operation between German-speaking states within the framework of the working group D-A-CH (D for Germany, A for Austria, CH for Switzerland) was continued. The annual meeting provided a fruitful exchange of ideas on topics such as the implementation of the Measuring Instruments Directive, the notification of the conformity assessment bodies or on the non-conformities detected through market surveillance.

Conformity Assessment and Approval

The certification body *METAS-Cert*, in operation since spring 2006, is recognised within the bilateral agreement on conformity assessments and in accordance with the European Measuring Instruments Directive and the directive of non-automatic weighing instruments as notified conformity assessment body. *METAS-Cert*, with the identification number 1259, competes directly with all other European providers. *METinfo 3/2006* (www.metas.ch/METinfo-3-2006) recently published a descriptive article on the operational scope of the certification body.

The year 2006 proved to be decidedly labour-intensive for METAS as it had to coordinate both the last of the approvals following the old requirements prior to 30 October and the strong demand for conformity assessment in compliance with the new ordinances to enable Swiss manufacturers to place their products on the Swiss and EU market, following the commencement of the revisions on the 30 October 2006.

Due to its success, the certification body *METAS-Cert* was able to issue seven certificates of conformity based on quality assurance of the production process for several notable Swiss manufacturers, plus one type examination certificate already in 2006. In addition, during the report year *METAS-Cert* awarded a total of 84 conformity certificates for the placing on the market of measuring instruments, on the basis of product verification, for weighing instruments and measuring instruments for electrical energy and power.

The diagrams 1 and 2 on page 11 show the number of type approvals, conformity assessments and verifications in comparison to the two previous years. Diagram 1 shows the impressive growth of approvals and conformity assessments recorded during the report year. The number of verifications by METAS, compared to the figures of the Swiss Verification Service, conveys a picture of the office's complementary activities in this field. METAS verified 1358 measuring instruments in areas, for which no services are offered by the verification offices and verification laboratories.



New Verification Marks

A measuring instrument placed legally on the market in accordance with the new procedure no longer requires an initial verification and may be employed until expiry of validity specified in the corresponding ordinance. In order to be able to continue usage of an instrument subject to legal regulations, the user has to apply for re-verification prior to expiry of validity. After re-verification, a new verification mark (see picture on page 11) showing the identification of the authorising body and the expiry date of the verification (month, year) is placed on the instrument.

Surveillance and Enforcement

The newly modular-structured verification officer training course was successfully completed. The eleven participants passed the final examination and may therefore officially bear the title «Certified Verification Officer». The co-operation with the cantonal surveillance authorities was intensified within the framework of the ordinance revisions and the project on regional collaboration in Central Switzerland.

The *Swiss Verification Service*, which comprises of 49 cantonal verification offices and 77 privately organised verification laboratories, verified 393 768 measuring instruments, examined 793 000 measuring instruments by statistical methods and inspected more than 8498 batches of pre-packaged goods. In 2006 6.8 % of the batches had to be disapproved. Further details can be found in the Annual Report 2006 of the Swiss Verification Service (www.metas.ch/jb-verification).

Each year around 60 000 GWh electrical energy is generated in Switzerland and supplied to consumers. The converted energy corresponds to a market value of 12 billion Swiss francs. In order to ensure that the electrical energy charged to the consumer is also correctly measured, METAS inspects the compliance with the new conformity assessment procedures. Additionally, private verification laboratories authorised and supervised by METAS ensure that the electricity meters and transformers employed are accurately verified and maintained.



Diagram 1

Type Approvals and Conformity Assessments

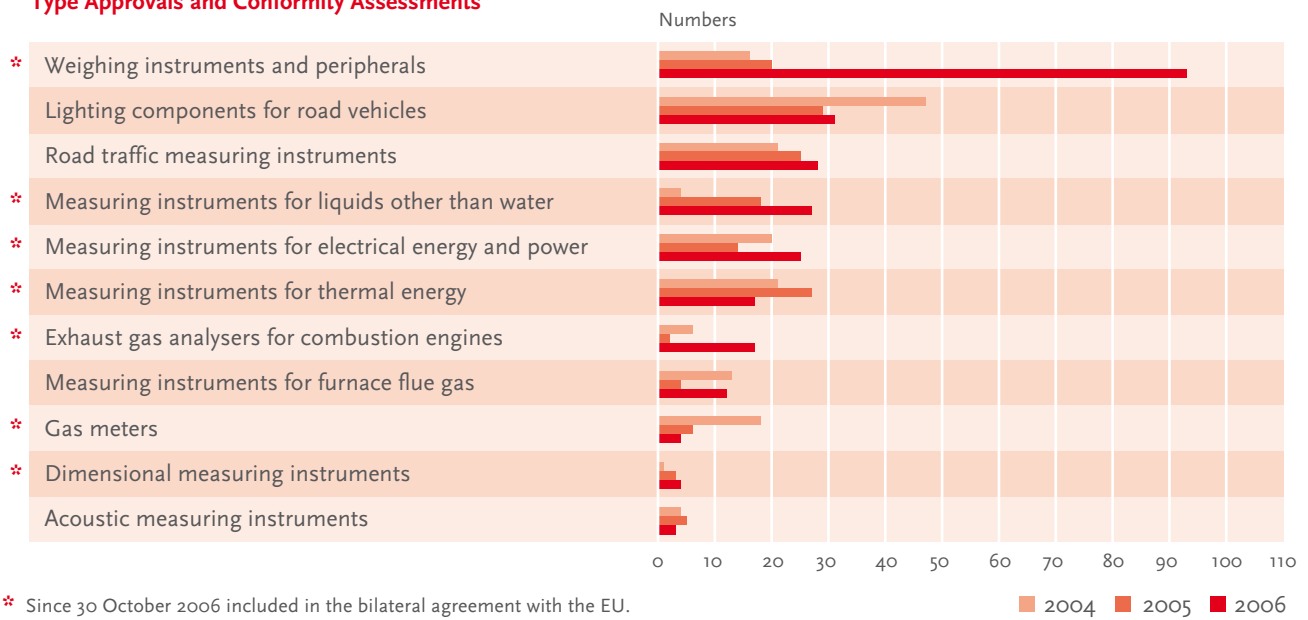
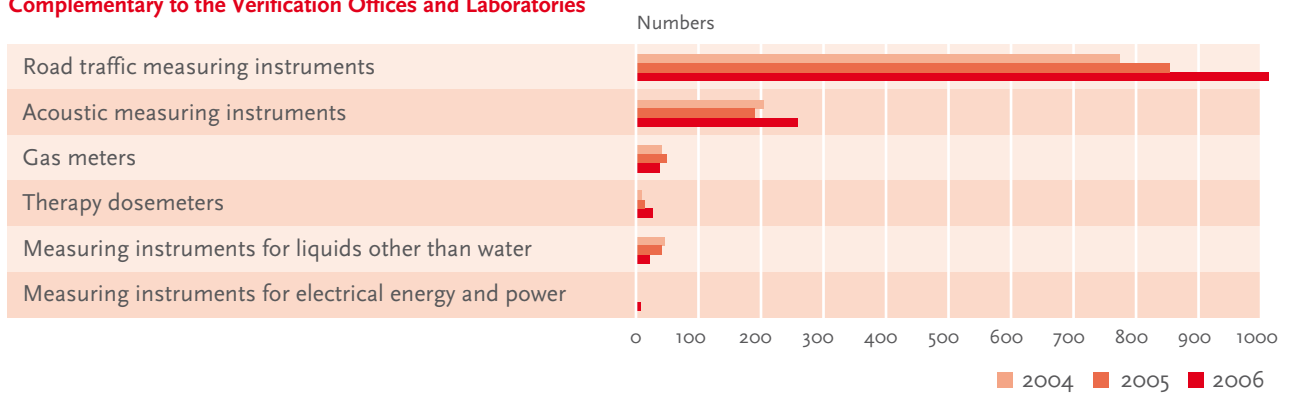


Diagram 2

Verifications Performed by METAS Complementary to the Verification Offices and Laboratories



Constantly Increasing Demand

The Swiss economy grew strongly once again in 2006. Measurements play an important role here, whether in the development of new products, the surveillance of manufacturing processes or during the final inspections. Accordingly, the demand for metrological services in the industrial field and in the service sector has also risen by 12 per cent to 2.8 million francs.

The diagram on page 13 shows the earnings and the number of certificates issued over the past three years in the major technical fields. The increase in services involved almost all measurable quantities, in particular mass as well as the optical, electric and dimensional quantities. This can also be ascribed largely to the continuing expansion of the range of services provided with new or improved measurement facilities, as is illustrated in the final section.

Standardisation Provides Safety and Prosperity

The performance of highest-accuracy calibrations and testings for the subsequent infrastructure of calibration and verification laboratories constitutes the chief task of METAS. This work necessitates the personnel to possess profound technical know-how and solid experience in many fields, as required too by the standardisation. In 2006, METAS specialists co-operated successfully in over 20 Technical Committees of various standards organisations. Therewith, they provide an important contribution toward safety and prosperity of the consumer in the cross-linked world economy.

Since 2004, the leading standards organisation in the electrotechnical field, the *International Electrotechnical Commission (IEC)*, has awarded the *IEC-1906-Award* for exemplary performance in the field of standards. In 2006 Heinrich Ryser, research assistant, received the coveted prize for his numerous contributions toward the standardisation of measurement and test procedures in the field of electromagnetic compatibility. Electrical and electronic equipment should be resistant to interfering signals from other sources and likewise should not emit any harmful signals themselves. The testing of the electromagnetic compatibility of such equipment is a complex and therefore costly undertaking. With his research, Ryser has contributed significantly toward the possibility of achieving reliable test results using simplified and cheaper methods.

New or Improved Measuring Facilities and Services

Research and industry are constantly placing new measuring instruments on the market. This, in turn, expects the national metrology institutes (NMIs), such as METAS, to also calibrate or test these instruments to the necessary accuracy. In order for the NMIs to perform this task, they have to continually adapt their measuring facilities and competences to satisfy the latest technical demands. The intensive co-operation between the NMIs ensures that no country has to conduct the necessary research and development entirely on its own. Given the fact that NMIs all over the world are largely state-financed, co-operation is generally straightforward and unhindered by patent laws and profit considerations.

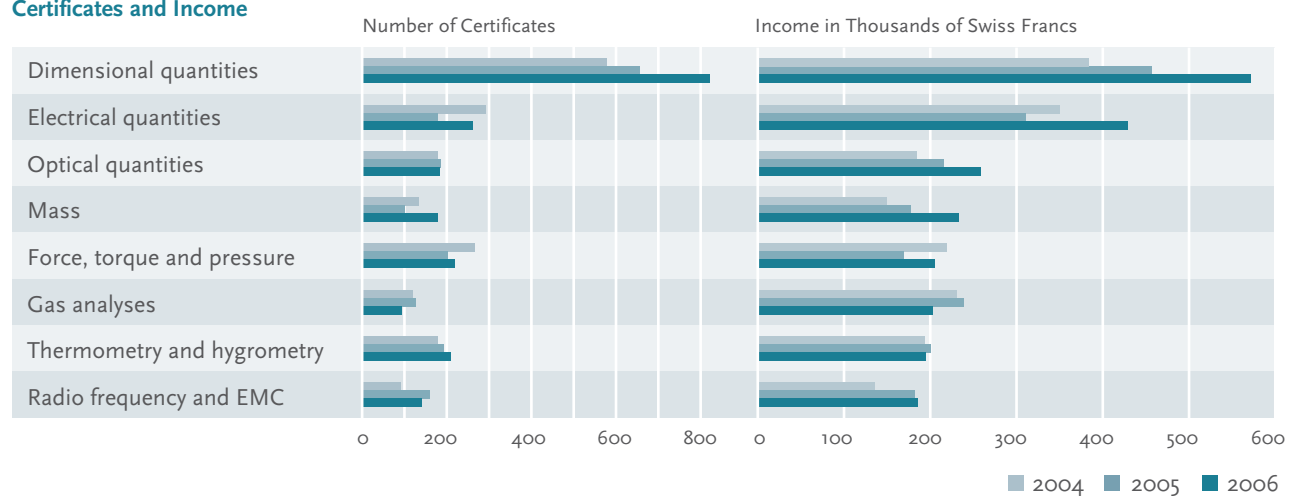
The chart on pages 13 and 14 gives an overall view of the major measuring facilities and services newly introduced or improved in 2006. They include once again a broad spectrum of services, whose impact ranges from industrial manufacturing to information transfer and livestock farming.

Measurement comparisons organised by METAS, involving ten laboratories from Switzerland and two from Germany, confirm that code-selective measurement is suitable for the assessment of UMTS radiation from base stations, as proposed by the measurement recommendation of 2003, edited by the Federal Offices of Metrology (METAS) and of Environment (FOEN).





Certificates and Income



New or Improved Measurement Facilities and Services 2006

| Measurement Facility or Service | Application |
|--|---|
| Micro coordinate measuring machine: Faster and more accurate dimensional measurement of small parts using a probingsphere shape-correction in scanning mode; typical measurement uncertainty 20 nm to 80 nm. | Microtechnology, watch industry, microoptics, medical technology, automobile industry, space technology |
| Measurement of the spectral diffuse reflection of white and coloured standards. | Colour measurement in industry |
| Manufacture and sale of fibre optic standards for the calibration of instruments for the measurement of optical reflection and back-scattering in glass fibres (OTDR). | Telecommunications |
| Calibration of measuring instruments for polarisation mode dispersion (PMD measuring instruments). | Telecommunications |
| New phase measuring facility for the comparison of frequency standards of customers in the range 1 MHz to 30 MHz; simplified application; improved measurement uncertainty. | Telecommunications, watch industry, accurate time measurement |
| Comparator for the measurement of mass (in the range to 1 kg) under high vacuum (< 0.000 1 Pa). | Ultra-precise weighing technology |
| Static expansion system for the range 0.000 01 Pa to 1000 Pa with a relative measurement uncertainty between 5 % and 0.1 %. | Vacuum and sensor manufacturing |
| Pressure balance for the range 5 kPa to 200 kPa with a measurement uncertainty between 0.4 Pa and 2 Pa. | Aerospace, weather forecasting, sensor manufacturing |



New or Improved Measurement Facilities and Services 2006 (Continuation)

| Measurement Facility or Service | Application |
|--|--|
| <i>Laser Doppler Velocimetry</i> for the measurement of flow profiles in piping. | Measurement of flow and thermal energy for accounting purposes |
| Calibration of electrometers for the measurement of very small currents; measurement range 10 fA to 0.1 A; measurement uncertainty 400 ppm to 2 ppm. | Electronic semiconductor industry, sensor manufacturing, biological sciences, medicine, etc. |
| Improved calibration of standard capacitors; measurement range 1 pF to 100 nF; frequency 1 kHz; measurement uncertainty 1 ppm. | High precision electrical measurements, instrument design, sensor manufacturing |
| Measurement of loss factors of standard capacitors, measurement range 0 to 0.1; frequency 50 Hz to 20 kHz; measurement uncertainty from $5 \cdot 10^{-6}$. | High precision electrical measurements, instrument design, sensor manufacturing |
| Improved calibration of thermometry bridges equipped with resistive sensors (e. g. Pt-100); measurement range 1 Ω to 1.2 k Ω ; measurement uncertainty from 0.2 ppm. | High precision temperature measurements; sensor manufacturing, biological sciences, etc. |
| Improved measurement of low AC voltages of 2 mV and higher; improvement of measurement uncertainty to the factor 8. | High precision electrical measurements, instrument design, sensor manufacturing, etc. |
| Improved calibration of noise generators (noise power, ENR); frequency range 10 MHz to 18 GHz; ENR 5 dB to 34 dB; measurement uncertainty 0.15 dB to 0.4 dB. | Low-noise amplifiers in radar technology, medical technology etc. |
| Improved calibration of power meters; frequency range 0 GHz to 40 GHz; measurement uncertainty < 3 %. | Microwave communications |
| Measurement of <i>Normalized Site Attenuation</i> of EMC testing halls; measurement uncertainty < 3 dB. | Electromagnetic compatibility of electrical and electronic appliances and facilities |
| Calibration of current clamps for frequencies up to 100 MHz | Electromagnetic compatibility of electrical and electronic appliances and facilities |
| Calibration of the amount fraction of ammonia in gas mixtures in pressure cylinders and in measuring instruments; measurement range approx. 30 nmol/mol to approx. 800 nmol/mol; measurement uncertainty 3 % to 5 %. | Environmental protection, air pollution control |
| Calibration of instruments for the measurement of amount fraction of ethyl benzene; measurement range approx. 10 nmol/mol to approx. 100 nmol/mol; measurement uncertainty 2 % to 5 %. | Environmental protection, air pollution control |
| Controlled production of larger amounts of combustion aerosol up to 20 L/min for the calibration of several particle analyzers. | Air pollution control; fine particle measurement |
| Improved signal simulation of road traffic to test speed-measuring systems (radar, laser and inductive equipment); improved measurement uncertainty of 0.01 % to 0.1 %. | Traffic surveillance |
| Measuring facility to simulate special movement (longitudinal, lateral and vertical) for the testing of GPS receivers, which serve as reference speed or acceleration measuring instruments. | Traffic surveillance, automobile industry |

To be or not to be ...

In the context of the Federal Administration Reform 05/07, the Federal Chancellery ordered in autumn 2006 the re-view of necessity of all extra parliamentary commissions. After having held over 200 meetings and almost 96 years of existence, the Federal Commission of Metrology thus found itself in the situation of having to address the question of its own existence.



The Federal Commission of Metrology is composed as follows:

Dr Xavier Edelmann, Chairman

Member of the Management Board of the Federal Materials Testing and Research Institute (EMPA), CH-9014 St. Gall (member since 2001)

Chantal Nagel, Deputy Chairwoman

Chief Editor, Swiss Gas and Water Board, CH-8027 Zurich (member since 1997)

Dr Marco Bertoli

Director, Verzasca SA, CH-6616 Losone (member since 1997)

Laura Grüter-Bachmann

Head of Trade Police Lucerne
CH-6000 Lucerne 11
(member since 2004)

Prof. Dr Jakob Roth

Head of Radiological Physics, Basel
Canton Hospital, CH-4031 Basel
(member since 2001)

Prof. Dr Ursula Spichiger

Head of the Centre for Chemical Sensors
and Chemical Information Technology,
Swiss Federal Institute of Technology,
CH-8005 Zurich (member since 2001)

Federal Commission of Metrology

Report 2006

For almost a century now, the Federal Commission of Metrology (FCM) has provided METAS with valuable services. It is an essential turntable between industry, research, public authorities and METAS and in this function represents the customers' interests and concerns at METAS. In contrast to costly specialist services, the expertise and experience of the FCM members can be accessed swiftly and inexpensively.

Furthermore, the members of the commission are also technically competent and practice-experienced contact persons for issues concerning the objectives and strategies of METAS. The commission also acts as consultative board to the Federal Department of Justice and Police (FDJP) in metrological issues and passes judgment on appeals filed against decisions made by METAS.

At the close of 2006, METAS and the commission were very satisfied to learn that the FCM did not feature on the list of commissions to be dissolved or merged. In addition to this existential issue, the themes addressed by the commission last year also included the following:

- Conclusion of the project Review of Legal Metrology, launched several years ago, in view of an adaptation to the EU/EC's new Measuring Instruments Directive;
- Transfer of the Swiss Accreditation Service (SAS) from METAS to the State Secretariat of Economic Affairs (SECO);
- Implementation of the Federal Government's corporate design and modification of the METAS organisation chart as of 1 April 2006;
- Performance agreements 2006 and 2007 and also performance mandate 2008–2011;
- Work cancellation plan together with the reduction and centralisation of personnel and finance services;
- METAS's national und international relations.

9014 St Gall, 12 February 2007

X. Edelmann

Dr Xavier Edelmann, Chairman





Additional Revenue at Lower Costs

The 2006 net operating result of the Federal Office of Metrology (METAS) returned a revenue of 14.4 (13.6 million the previous year) against costs of 39.3 (40.9) million francs. Thanks to 0.8 million francs additional revenue and 1.6 million francs lower costs compared to the previous year, the result improved by 2.4 million francs. The cost coverage thereby rose from 33 % to 37 %.

The total costs of 39.3 million francs are divided as following:

- 21.7 million francs personnel expenses (55 %);
- 7.1 million francs rental costs (18 %);
- 4.3 million francs material expenses (infrastructure, operation, services provided by others, 11 %);
- 3.9 million francs calculated depreciation and interest (10 %) and
- 2.3 million francs remaining costs (6 %).

As the Swiss Accreditation Service (SAS) was transferred on the 1 April 2006 to the State Secretariat of Economic Affairs (SECO) and the administrative procedures of this transfer were completed at the end of 2006, the financial figures of the SAS feature for the last time in the METAS Annual Report.

The product group National Standards

gave rise to costs of 21.2 million francs (22.1 the previous year). This product group includes all the basic standards and preliminary services, which METAS is legally obliged to perform by the law on metrology. These activities constitute essential metrological prerequisites for the product groups *Legal Metrology* and *Industrial Metrology*. For this reason, this product group cannot show any revenue.

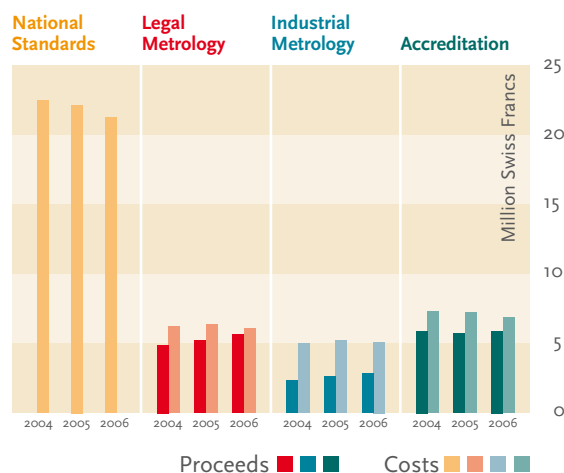
The product group Legal Metrology

showed proceeds of 5.7 (5.2 the previous year) against costs of 6.1 (6.4) million francs. The cost coverage rate increased from 82 % to 93 %. The revised ordinances, which came into effect on 30 October 2006, led, on the one hand, to an unexpected increase in Swiss approvals in compliance with the old regulations. On the other hand, a significant premature demand for conformity assessments following the new regulations was recorded. Furthermore, more initial verifications were recorded due to the positive economic development. This explains the 500 000-franc increase in revenue compared to the previous year. However, a slight drop in the future revenue of this product group is anticipated.

The product group Industrial Metrology

earned 2.8 million francs (2.6 the previous year) against costs of 5.1 (5.2) million francs. The cost coverage rate rose from 50 % to 56 %. Consistent with the positive economic development, the demand for services rose again last year. The continuous rationalisation of all processes also had a favourable effect on cost coverage.

Proceeds and Costs by Product Groups



The product group Accreditation

showed proceeds of 5.9 (5.7 the previous year) against costs of 6.9 (7.2) million francs. Thanks to 200 000 francs additional revenue and 300 000 francs lower expenditure in comparison to the previous year, the cost coverage rate increased from 79 % to 86 %. Further details are to be found in the Swiss Accreditation Service's annual report: www.seco.admin.ch/sas/00034/00083/index.html?lang=en.

Proceeds and Costs by Types of Expenditures

| | Account 2004 | | Account 2005 | | Account 2006 | |
|---|---------------|---------------|---------------|---------------|---------------|---------------|
| | Mio. CHF | | Mio. CHF | | Mio. CHF | |
| Revenues and expenditures | | | | | | |
| Global revenues | 12.797 | | 13.109 | | 14.118 | |
| Personnel expenses | | 22.540 | | 21.883 | | 21.662 |
| Material expenses | | 4.341 | | 5.027 | | 4.328 |
| Allocation to appropriated reserves | | | | 0.479 | | 0.239 |
| Contributions to international organisations | | 0.308 | | 0.286 | | 0.318 |
| Investments | | 3.796 | | 5.005 | | 3.739 |
| Total revenues and expenditures | 12.797 | 30.985 | 13.109 | 32.680 | 14.118 | 30.286 |
| Proceeds and costs as well as pro forma invoiced performances and services | | | | | | |
| Performances provided to other federal bodies | 0.372 | | 0.465 | | 0.289 | |
| Services provided by other federal bodies | | 7.688 | | 7.671 | | 7.456 |
| Investments and pay off amounts | | | | | | |
| Investments for instruments, machines and cars | | -1.853 | | -3.227 | | -2.500 |
| Pay off for instruments, machines and cars | | 3.398 | | 3.323 | | 3.255 |
| Pay off | | 0.778 | | 0.588 | | 0.565 |
| Evaluations and deferrals | | | | | | |
| Stocks fluctuations and deferrals | | 0.047 | | 0.298 | | 0.351 |
| Withdrawal from appropriated reserves | | | | 0.378 | | 0.479 |
| Allocation to appropriated reserves | | | | -0.479 | | -0.239 |
| Contributions to international organisations | | | | -0.286 | | -0.318 |
| Total proceeds and costs | 13.169 | 41.043 | 13.574 | 40.946 | 14.407 | 39.335 |

Proceeds and Costs by Product Groups

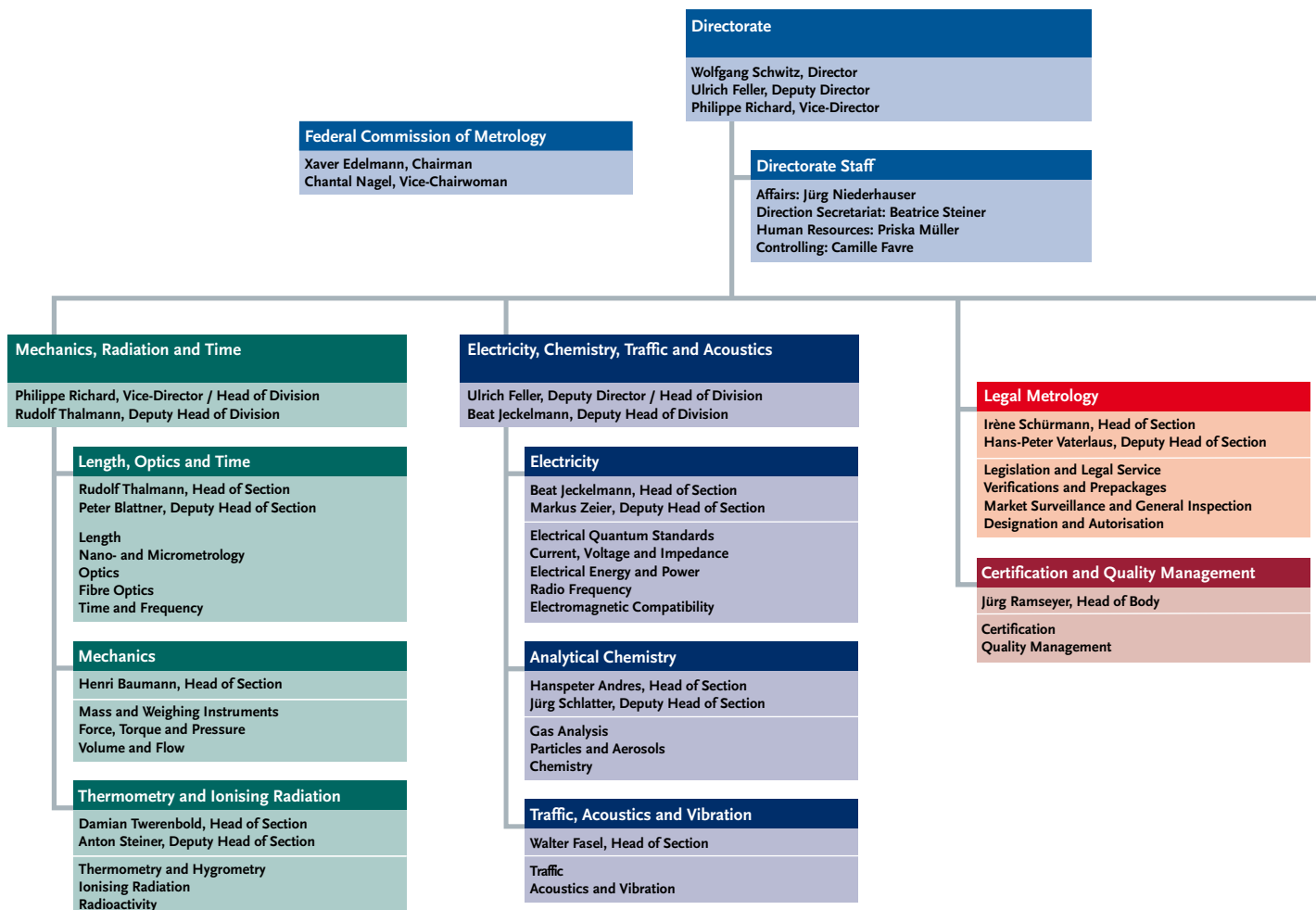
| | Account 2004 | Account 2005 | Account 2006 |
|---------------------------------|--------------|--------------|--------------|
| | Mio. CHF | Mio. CHF | Mio. CHF |
| National Standards | | | |
| Proceeds | 0.000 | 0.000 | 0.000 |
| Costs | 22.484 | 22.147 | 21.238 |
| Coverage Rate | 0 % | 0 % | 0 % |
| Legal Metrology | | | |
| Proceeds | 4.907 | 5.205 | 5.657 |
| Costs | 6.243 | 6.352 | 6.069 |
| Coverage Rate | 79 % | 82 % | 93 % |
| Industrial Metrology | | | |
| Proceeds | 2.361 | 2.622 | 2.843 |
| Costs | 4.993 | 5.212 | 5.113 |
| Coverage Rate | 47 % | 50 % | 56 % |
| Accreditation | | | |
| Proceeds | 5.901 | 5.747 | 5.905 |
| Costs | 7.323 | 7.235 | 6.883 |
| Coverage Rate | 81 % | 79 % | 86 % |
| Total proceeds and costs | | | |
| Proceeds | 13.169 | 13.574 | 14.405 |
| Costs | 41.043 | 40.946 | 39.303 |
| Coverage Rate | 32 % | 33 % | 37 % |



Personnel Changes

The management extends its warmest thanks to the retired members of staff for their many years of successful work in the service of metrology: Dr Bruno Vaucher, Deputy Director, Head of Division Mechanics, Radiation and Time; Jean-François Perrochet, Head of Section Analytical Chemistry; Jean-Georges Ulrich, Head of Section Legal Metrology.

The management congratulates various members of staff on their promotion and wishes them every success and satisfaction in their new functions: Dr Ulrich Feller, Deputy Director, (hitherto Vice-Director); Dr Philippe Richard, Vice-Director and Head of Division Mechanics, Radiation and Time (hitherto Head of Section Mechanics); Dr Henri Baumann, Head of Section Mechanics (hitherto Deputy Head of Section Mechanics); Dr Hanspeter Andres, Head of Section Analytical Chemistry (new at METAS); Dr Irène Schürmann, Head of Section Legal Metrology (hitherto Head of Legal Service).



As of 1st May 2007

Technical Terms

Accreditation

Formal recognition of the competence of a calibration, testing, inspection or certification service to carry out specific tests or conformity assessments according to internationally specified requirements.

Accuracy

Closeness of the agreement between the result of a measurement and the value of the quantity.

Approval

Authorisation of measuring instruments of a particular pattern or of an individual measuring instrument for verification or use.

Base Unit

One of several determined units of a system of units which are required to define all other units of the system.

Calibration

Set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realised by standards.

Certification

Procedures by which a third party confirms in writing that a product, process or service conforms to pre-specified requirements.

Conformity Assessment

Systematic analysis of the extent to which products, or the conditions under which they are manufactured, transported or stored, fulfil technical requirements or standards.

Material Measure

Device intended to reproduce or supply, in a permanent manner during its use, one or more known values of a given quantity (scaled ruler, weights, measure of volume).

Measurement

Set of operations having the object of determining the values of a quantity.

Measurement Uncertainty

Part of the result of a measurement characterising the dispersion of the values which must be assigned to the measured quantity.

Metrology

Science and technique of measurement.

Quality

Totality of characteristics of a product or a service that bear on its ability to satisfy stated and implied needs.

Reference Material

Material or substance of sufficient homogeneity one or more of whose characteristics are well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Standard

Material measure, measuring instrument, reference material or measuring system intended to define, realise, conserve or reproduce a unit or one or more values of a quantity to serve as a reference.

Traceability

Property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties.

Verification

Sequence of operations carried out by an empowered authority or organisation to test and confirm that a measuring device satisfies legal regulations.

Business Management, Informatics
and Communication

Peter Demostene, Head of Sector

Finances and Administration
Metrological Informatics
Technical Communication and Promotion

Technics and Development

Thomas Krebs, Head of Sector

Development Support
Technical Services
Electronics Development
Buildings and Infrastructure

Articles and Conference Participation

The METAS employees offer their specialised knowledge in many ways to experts, clients and the general public. They encourage the transfer of knowledge through participating at conferences, scientific publications and frequent lecture activities.

Specialists at METAS write articles for METInfo, the Journal of Metrology, which METAS publishes three times annually. This magazine is available free of charge and can be subscribed to at www.metas.ch/ order. In addition, scientific reports from METAS appear in technical publications both in Switzerland and abroad. METAS employees also participate as speakers at international conferences, hold lectures and organise further training courses. The scientific publications are to be found at www.metas.ch/ publications.

369 persons, divided into 30 groups, took part in guided tours of the Federal Office of Metrology in 2006. The specialists at METAS are happily willing to receive groups of interested persons and to demonstrate their responsibilities and fields of activity. This includes, in particular, a look at the highly scientific world of the laboratories and the impressive technical installations in the extension buildings. Please contact the receptionists, phone +41 31 32 33 111, info@metas.ch, who will be pleased to arrange an appointment.

Specialist Articles

| Author(s) | Title | Journal |
|--|--|--|
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| G. Dudle | Einzigartige Primärfrequenznormale am METAS | METInfo, Vol. 13, No. 3, S. 9–13, 2006 |
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| U. Feller | Referenzmasse, eine Staatsaufgabe | SGA-Bulletin (Schweizerische Gesellschaft für Automatik), Nr. 44, S. 24, 2006 |
| P. Fuchs | Genauere Messungen dank Massebestimmung unter Konstantdruck | METInfo, Vol. 13, No. 1, S. 21–23, 2006 |
| P. Fuchs | Dem Kilogramm auf der Spur | METInfo, Vol. 13, No. 1, S. 24–25, 2006 |
| J. Furrer | Kompetenz der METAS-HF-Leistungsmessung bis 50 GHz bestätigt | METInfo, Vol. 13, No. 3, S. 14–15, 2006 |
| T. P. Crowley, J. Miall, J. P. M. de Vree-de, J. Furrer , A. Michaud, E. Dressler, T. Zhang, K. Shimaoka, J. H. Kim | CCEM.RF-S1.CL (GTRF/02-03): RF power measurements with 2.4 mm connectors | Metrologia, 43, Tech. Suppl. 01007, 2006 |
| H.-P. Haerri, D. Schwaller | SI-traceable Mass Spectrometric Analysis of Gas Mixtures | Abstract: Chimia, 60, No. 7/8, p. 381, 2006 |
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| A. Küng, F. Meli, R. Thalmann | Ultra precision micro-CMM using a low force 3D touch probe | Measurement Science and Technology, Vol. 18, No. 2, pp. 319–327, 2007 |

METAS staff

Specialist Articles (Continuation)

| Author(s) | Title | Journal |
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| H. Lehmann, P. Blattner | METAS dreht den Spiegel | METInfo, Vol. 13, No. 2, S. 4–7, 2006 |
| F. Meli, A. Küng | AFM investigation on possible surface damages caused by mechanical probing with small ruby spheres | Measurement Science and Technology, Vol. 18, No. 2, pp. 496–502, 2007 |
| I. Vayshenker, K. Amemiya, J. Morel | Trilateral Optical Power Meter – Comparison between NIST, NMIJ/AIST and METAS | Applied optics, Vol. 46, No. 5, 2007 |
| J. Viallon, P. Moussay, M. Esler, R. Wielgosz, W. Bremser, J. Novák, M. Vokoun, A. Botha, M. J. Van Rensburg, C. Zellweger, S. Goldthorp, A. Borowiak, F. Lagler, J. Walden, E. Malgeri, M. P. Sassi, P. Morillo Gomez, R. Fernandez Patier, D. Galan Madruza, J.-C. Woo, Y. D. Kim, T. Macé, C. Sutour, A. Surget, B. Niederhauser, D. Schwaller, B. Frigy, I. Györgyné Váraljai, S. Hashimoto, H. Mukai, H. Tanimoto, H.-P. Ahleson, A. Egeløv, N. Ladegard, L. Marsteen, K. Tørnkvist, F. R. Guenther, J. E. Norris, T. L. Hafkenscheid, M. M. Van Rijn, P. Quincey, B. Sweeney, S. Langer, B. Magnusson, J. Bastian, V. Stummer, M. Fröhlich, A. Wolf, Leonid A. Konopelko, Y. A. Kustikov, D. V. Rumyanstev | International Comparison CCQM-P28: Ozone at ambient level | Metrologia 43, No 1A, Technical Supplement 08010, 2006 |
| J. Niederhauser | Von Quantensprüngen und Siebenmeilenstiefeln | METInfo, Vol. 13, No. 3, S. 28–29, 2006 |
| F. Overney, B. Jeanneret, B. Jeckelmann, B. M. Wood, J. Schurr | The quantized Hall resistance: towards a primary standard of impedance | Metrologia 43, pp. 409–413, 2006 |
| F. Pythoud | CCEM.RF-K20: Comparison of electrical field strength measurements | Metrologia, 43, Tech. Suppl. 01006, 2006 |
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| U. Marti, P. Richard | LSN2004: Landeschwerenetz 2004, Station Brig | swisstopo-Report 05-14, Juli 2006 |
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| P. Boehler, J. Schlatter | Mobile Kalibrierungen von Aerosolmessgeräten | METInfo, Vol. 13, No. 1, S. 26–27, 2006 |
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| A. Steiner, G. Zwahlen, S. Joss | Réalisation améliorée du point triple de l'argon | METInfo, Vol. 13, No. 2, pp. 9–12, 2006 |
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| R. Thalmann | Basics of highest accuracy roundness measurement | Memorias Simposio de Metrologia, Querétaro, Mexico, 2006 |
| R. Thalmann, F. Meli, A. Küng | Taktile Mikrokoordinatenmesstechnik an den Grenzen | VDI-Berichte 1950, Messtechnik für Mikro- und Nano-Engineering, S. 67–76, 2006 |
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| C. Wüthrich, M. Coulibaly | The determination of volume ratios by gas depletion through multiple expansions | Vacuum, 81, pp. 453–458, 2006 |
| C. Wüthrich, T. Sauter | An algorithm for fast regulation of dynamically-generated pressures in the range 1 Pa to 7 kPa | Vacuum, 81, pp. 562–565, 2006 |
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METAS staff

Transfer of Knowledge

Conference and Seminar Contributions

| Author(s) | Title | Journal |
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| U. Müller, M. Dues, H. Baumann | Bewertung der Strömungsverhältnisse von Kalibrier-Prüfständen mittels LDV-Messungen und Kennzahlen, Lasermethoden in der Strömungsmesstechnik | Lasermethoden in der Strömungstechnik, 14. Fachtagung, 5.–7. September 2006, Braunschweig |
| U. Müller, H. Baumann | Erfassung von Geschwindigkeitsverteilungen zur Beurteilung der Empfindlichkeit von Durchflusssensoren, Lasermethoden in der Strömungsmesstechnik | Lasermethoden in der Strömungstechnik, 14. Fachtagung, 5.–7. September 2006, Braunschweig |
| H. Baumann , G. Cignolo, M. Clausen , R. Gorla | A comparison between Italian and Swiss gas flow standards in the range of 0.3 m ³ /h to 25 m ³ /h | International Symposium on Fluid Flow Measurement, 16–18 May 2006, Querétaro, Mexico |
| H. Dudli, P. Blattner | Oberflächenschutzsysteme an Tunnelwänden | Licht 2006, 11. September 2006, Bern |
| P. Blattner, H. Dudli | Mobiles Fahrbahnoberflächenreflektometer | Licht 2006, 11. September 2006, Bern |
| F. Fäuzesi, N. Castagna, M.D. Plimmer, A. Jornod, G. Dudle , P. Thomann | FOCS-2 Design of an improved continuous cesium atomic fountain clock | European Time and Frequency Forum, 27–30 March 2006, Braunschweig |
| G. Dudle | Métrieologie temps et fréquence : Vous avez une seconde ? | Présentation à l'Association des femmes universitaires, 6 septembre 2006, Fribourg |
| G. Dudle | Zeit und Frequenzmetrologie | Weiterbildungskurs für Realschullehrer des Kantons Bern, 12. Oktober 2006, Bern-Wabern |
| A. L. Eichenberger, A. Joyet, B. Jeckelmann, B. Jeanneret, P. Richard | Mechanical improvements in the METAS watt balance | Conference on Precision Electromagnetic Measurements, 9–14 July 2006, Torino, Conf. Digest, pp. 62–63 |
| W. Fasel | Neuerungen im gesetzlichen Messwesen | Jubiläumsanlass der Bredar AG, 9. Juni 2006, Bern |
| W. Fasel | Allgemeines zur Geschwindigkeitsmessproblematik | Jahresmeeting der Multanova AG, 30. August 2006, Neuenburg |
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| U. Feller | Leistungs- und Wirkungsmessung beim Bundesamt für Metrologie | Interface Institut für Politikstudien, 6. Dezember 2006, Luzern |
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| J. Furrer | Kalibrierfaktoren in der HF-Leistungsmessung | Interessengruppe für elektrische Kalibrier- und Prüftechnik, 1. Februar 2006, Bern-Wabern |
| J. Furrer | Calibration of RF-Voltage on Oscilloscopes (Overview) | ANAMET Meeting, 25 March 2006, Teddington, UK |
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| B. Jeckelmann | Quantum standards in electrical metrology | International school of physics <i>Enrico Fermi</i> , Course CXLVI <i>Advances in Metrology and Fundamental Constants</i> , 18–28 July 2006, Varenna, Italy |
| R. Goebel, F. Delahaye, B. Jeckelmann , F. Schopfer, W. Poirier | Preliminary investigations of the use of quantum Hall array resistance standards as travelling standards | Conference on Precision Electromagnetic Measurements, 9–14 July 2006, Torino, Conf. Digest, p. 514 |

METAS staff

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| Author(s) | Title | Journal |
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| B. Jeckelmann | DC-Stromkalibrierung von Femtoampere bis Kiloampere | Interessengruppe für elektrische Kalibrier- und Prüftechnik, 1. Februar 2006, Bern-Wabern |
| B. Jeckelmann | Einflussgrößen bei elektrischen Kalibrierungen im DC-Bereich | VDI-Fachtagung <i>Messunsicherheit praxisingerecht bestimmen</i> , 13. bis 15. November 2006, Erfurt; Proceedings: VDI-Berichte, Nr. 1947, S. 259–371, 2006 |
| A. Küng | Ultra precision micro-CMM using a low force 3D touch probe | NanoScale 2006: 7 th Seminar on Quantitative Microscopy (QM) and 3 rd Seminar on Nanoscale Calibration Standards and Methods, April 2006, Bern-Wabern |
| A. Küng, F. Meli | Scanning performance with an ultraprecision μ -CMM | 6 th Int. Conf. of the European Soc. for Precision Engineering and Nanotechnology (EUSPEN), May 2006, Baden bei Wien, Austria |
| F. Meli | AFM investigation on possible surface damages caused by mechanical probing with small ruby spheres | NanoScale 2006: 7 th Seminar on Quantitative Microscopy (QM) and 3 rd Seminar on Nanoscale Calibration Standards and Methods, April 2006, Bern-Wabern |
| F. Meli | Präzisions- und Mikromesstechnik mit neuem Koordinatenmessgerät und Tastsystem | Seminar der Swiss Association for Quality (SAQ), Sektion Ostschweiz, Interstaatliche Hochschule für Technik NTB, May 2006, Buchs SG |
| J. Morel | Das METAS-Faseroptiklabor | Seminarvortrag bei der Firma Agilent, 5. November 2006, Böblingen, Deutschland |
| F. Overney, B. Jeanneret, B. Jeckelmann, B. M. Wood, J. Schurr | The quantized Hall resistance: towards a primary standard of impedance | Conference on Precision Electromagnetic Measurements, 9–14 July 2006, Torino, Conf. Digest, p. 696 |
| F. Overney, B. Jeanneret, B. Jeckelmann | Realization of the Farad at METAS: Performance of the automated four terminal-Pair Ratio Bridge | Conference on Precision Electromagnetic Measurements, 9–14 July 2006, Torino, Conf. Digest, p. 478 |
| P. Richard | Redefinition of the kilogram based on a fundamental constant | International school of physics <i>Enrico Fermi</i> , Course CXLVI <i>Advances in Metrology and Fundamental Constants</i> , 18–28 July 2006, Varenna, Italy |
| P. Richard | A brief status report of the state of the world's Watt balances | CCM ad hoc Working Group on changes to the SI, Torino, July 9, 2006 |
| J. Rüfenacht | Verbinder-Effekte bei VNA-Messungen | Interessengruppe für elektrische Kalibrier- und Prüftechnik, 1. Februar 2006, Bern-Wabern |
| J. Rüfenacht | Metrological aspects of the new generation of VNAs | Agilent VNA Metrology Workshop, 27–29 March 2006, ETH, Zurich |
| J. Rüfenacht | VNA traceability challenges | Agilent VNA Metrology Workshop, 27.–29. March 2006, ETH, Zurich |
| J. Schlatter | Feinstaub – Was liegt da drin? | METAS-Seminar, 8. Februar 2006, Bern-Wabern |
| J. Schlatter | Feinstaub im Winter – Was liegt drin? | Vortrag anlässlich KLR-Seminar am METAS, 11. Mai 2006, Bern-Wabern |
| J. Schlatter | Kalibrierung von Partikelmessgeräten – Tätigkeiten des METAS | Erfahrungsaustausch OST-LUFT, 17. Mai 2006, Zürich |
| J. Schlatter, K. Auderset | Comparison of Condensation Particle Counter (CPC) and Laser Particle Counter | 10 th ETH-Conference on Combustion Generated Particles, 21 August 2006, Zurich |
| J. Schlatter | Comparison of Gripp am TSI Condensation Particle Counter | 10 th ETH-Conference on Combustion Generated Particles, 21 August 2006, Zurich |
| J. Schlatter | Ambient Pressure Impact on Particle Sizing with SMPS (Abstract) | 7 th International Aerosol Conference, 13 September 2006, St. Paul, MN, USA |
| D. Schwaller | Informatiklösung in der Sektion AC | METAS-Seminar, 8. November 2006, Bern-Wabern |
| W. Schwitz | Erfahrungen des METAS mit FLAG | Kaderausbildung armasuisse, 2. Februar und 9. März 2006, Thun |
| A. Steiner | Automatisierte Argon-Tripelpunktrealisierung | TEMPERATUR 2006, 16.–17. Mai 2006, PTB, Berlin |
| G. Stucki, P. Andreo | A Comparison Between Calculated and Experimental k_Q, Q_0 Electron Beam Quality Correction Factors for Various Plane-Parallel Chambers | World Congress on Medical Physics and Biomedical Engineering, 30 August 2006, Seoul, Südkorea |
| R. Thalmann | Basics of highest accuracy roundness measurement | CENAM Metrology Symposium, October 2006, Querétaro, Mexico |

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Transfer of Knowledge

Conference and Seminar Contributions (Continuation)

| Author(s) | Title | Journal |
|---------------------------|---|---|
| R. Thalmann | Ultra precision Micro-CMM using a low force 3D touch probe | Mexican CMM-Metrology Club, October 2006, Querétaro, Mexico |
| R. Thalmann | Kenngrossen der Oberflächenbeschaffenheit | SWISSMEM-Seminar Geometrische Produkt-Spezifikation (GPS) – Oberflächenbeschaffenheit, 23. November 2006, Dübendorf |
| R. Thalmann | Taktile Mikrokoordinatenmesstechnik an den Grenzen | VDI/VDE-Tagung Messtechnik für Mikro- und Nano-Engineering, 29. November 2006, Erlangen, Deutschland |
| D. Twerenbold | Temperaturmessung | Advanced Praxis-Seminar Prüf- und Kalibriertechnik, WIKA Manometer AG, 23. November 2006, Hitzkirch |
| S. Vörös, G. Stucki | Simulation Monte Carlo pour la réalisation d'un étalon primaire de la dose absorbée dans l'eau pour des faisceaux d'électrons | Journées Codes de calcul en radioprotection, radiophysique et dosimétrie à l'INSTN, organisées par la SFRPJ, 28 novembre 2006, Saclay, France |
| C. Wüthrich, M. Coulibaly | Traceability and calibration of the new static expansion system of METAS | Konferenz der Deutschen Physikalischen Gesellschaft, 26.–31. März 2006, Dresden, Deutschland |
| S. Wunderli | Projekt ChemMetro: Aktivitätsmessungen, Potentiometrie, Ampèrometrie; ionenselektive Elektroden, enzymdotierte Elektroden | Informationstagung zum Projekt ChemMetro, Elektrodenhersteller, Hochschulen, METAS, 30. März 2006, Bern-Wabern |
| S. Wunderli | Das neue Labor für Elektrochemie | METAS-Seminar, 17. Mai 2006, Bern-Wabern |
| S. Wunderli | Traceable ion activity measurements by ion selective electrodes | 20. EUROMET-Generalversammlung, 31. Mai 2006, Wien, Österreich |
| S. Wunderli | Rückverfolgbare Messungen der chemischen Aktivität mit Potentiometrie und Ampèrometrie | Abschieds-Veranstaltung für Prof. Dr. Hans Siegenthaler, Elektrochemie, Uni Bern, 23. Juni 2006, Bern |
| M. Zeier | Measurement Uncertainties in VNA Measurements | Agilent VNA Metrology Workshop, 27–29 March 2006, ETH, Zurich |
| M. Zeier | Messunsicherheitsbestimmung für komplexe Messgrössen | Neue Entwicklungen in der Messunsicherheitsermittlung, VDI/VDE-GMA-Workshop, 6.–7. April 2006, Ilmenau, Deutschland |
| M. Zeier | On the analysis of multidimensional quantities in measurement comparisons | Conference on Precision Electromagnetic Measurements, 9–14 July 2006, Torino, Conf. Digest, p. 458 |
| M. Zeier | Measurement Uncertainties in VNA Metrology | Invited Talk, Agilent, 20 October 2006, Santa Rosa, USA |

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