MITTATEKNIIKAN KESKUS

CENTRE FOR METROLOGY AND ACCREDITATION

Julkaisu J2/2001

FINNISH NATIONAL STANDARDS LABORATORIES

ANNUAL REPORT 2000

Helsinki 2001

MITTATEKNIIKAN KESKUS
CENTRE FOR METROLOGY AND ACCREDITATION

Julkaisu J2/2001

FINNISH NATIONAL STANDARDS LABORATORIES

ANNUAL REPORT 2000

Edited by
Jaana Järvinen

Helsinki 2001

PREFACE

The year 2000 was active in all metrology sectors in Finland. The number of metrology personnel of the Centre for Metrology and Accreditation (MIKES) was almost doubled to 27. The increase was a consequence of the coupling of metrology activities of the Technical Research Centre of Finland (VTT) to MIKES. The National Standards Laboratory for electricity, time and frequency maintained by VTT Automation and the National Standards Laboratory for dimensional quantities maintained by VTT Manufacturing Technology were administratively amalgamated to MIKES. Activities continue in these places as far as new premises for MIKES will be constructed.

During 2000 MIKES was approved as a member of the CCL (Consultative Committee for Length) which indicates the high standard of the Finnish length metrology. Previously, Finland has been represented in CCPR (CC for Photometry and Radiometry) and CCEM (CC for Electricity and Magnetism).

New metrology sectors has been established at MIKES: RF metrology and acoustics. Also the metrology in chemistry was initiated in 2000. All these will start effectively during the year 2001.

This publication contains general information on the Finnish metrological system and a summary of the activities of the Finnish National Standards Laboratories and Contract Laboratories in 2000. Hopefully you will find the information useful.

Helsinki, April 2001

Heikki Isotalo
Head of Metrology

CONTENTS

page

PREFACE 3

1. INTRODUCTION 7

2. NATIONAL MEASUREMENT SERVICE 8

2.1 DEFINITION 8

2.2 NATIONAL MEASUREMENT STANDARDS AND TRACEABILITY OF MEASUREMENTS 8

2.3 ORGANISATION OF THE MEASUREMENT SERVICE 9

2.4 INTERNATIONAL CO-OPERATION 12

3. ACTIVITIES OF THE NATIONAL STANDARDS LABORATORIES IN 2000 14

3.1 CALIBRATIONS 14

3.2 INTERNATIONAL COMPARISONS 15

3.3 PARTICIPATION IN THE EUROMET-PROJECTS 16

3.4 DEVELOPMENT PROJECTS 18

3.5 CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) 19

3.6 HELSINKI UNIVERSITY OF TECHNOLOGY (HUT) 45

3.7 FINNISH GEODETIC INSTITUTE (FGI) 58

3.8 RADIATION AND NUCLEAR SAFETY AUTHORITY (STUK) 64

4. ACTIVITIES OF THE CONTRACT LABORATORIES IN 2000 67

4.1 RAUTE PRECISION OY 67

4.2 TAMPERE UNIVERSITY OF TECHNOLOGY (TUT) 69

1. INTRODUCTION

The aim in maintaining and developing the National Measurement System is to support the competitiveness of the Finnish industry and the economy, to fulfil the needs of consumers and the society, and to integrate the Finnish metrological infrastructure with the European and international infrastructures.

Organisation of the National Measurement Standards System was launched by a Government Decree in 1978, considering especially the growing needs of industrial metrology. National standards were established for most of the basic units and some derived units by the Council of State which appointed a number of public research institutions as National Measurement Centres.

In 1994, according to a new Law on Units of Measurement and the National Measurement Standards, the Ministry of Trade and Industry was authorised to decide for which basic and derived SI units National Measurement Standards are realised and maintained. The authority to designate the National Standards Laboratories was delegated to the Centre for Metrology and Accreditation (MIKES).

2. NATIONAL MEASUREMENT SERVICE

2.1 DEFINITION

The Finnish National Measurement Service consists of National Standards Laboratories and the calibration laboratories accredited by MIKES. National Standards Laboratories are responsible for realisation of the SI system units, maintenance and development of the National Standards and the dissemination of the units determined within the National Measurement Standards to standards of lower accuracy. The services provided by the Accredited Calibration Laboratories are normally traceable to the National Measurement Standards maintained by National Standards Laboratories.

2.2 NATIONAL MEASUREMENT STANDARDS AND TRACEABILITY OF MEASUREMENTS

The principal task of the National Measurement Service is to create prerequisites for the traceability of physical measurements. Traceable measurements are a guarantee of quality and a base for MRA (Mutual Recognition Arrangement). Traceable measurements are generally required in applications for which regulations, standards or agreements specify requirements for the verification of measurements. These requirements include verification of measurements in accordance with industrial quality system standards, laboratory standards or the ISO standards.

Traceability means a link between the measurement results and the International or National Measurement Standards, obtained through an unbroken chain of comparisons (Fig. 1). Measurement standards can be instruments, devices or reference materials that are used to define, realise or maintain the measurement unit of a quantity or its multiples.

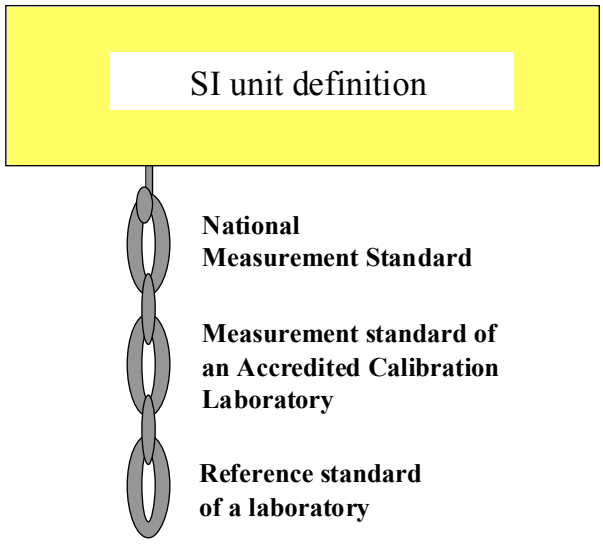


Fig. 1. Traceability chain.

Primary standards represent the best metrological quality of standards. In practice, they are standards by which the units of measurement are realised according to their internationally accepted definitions. These primary standards are used to disseminate the unit of the measurement to a lower level of accuracy i.e. to the secondary, reference and working standards.

In practice, the unbroken chain of comparisons is obtained by calibrating the measuring instruments. Calibration means a comparison in which the uncertainty of the instrument to be calibrated is determined using a more precise instrument of known uncertainty.

The measurement standards of the basic and derived units of the SI-unit system are the cornerstones of the traceable physical measurements. The traceability chains of the measurement standards of derived units are based, either directly or indirectly, on the

measurement standards of the basic units (metre, kilogram, second, ampere, kelvin, candela and mole).

All measurement results have a degree of uncertainty, which is an essential factor describing the quality of measurements as well as the quality of a measurement standard. National and international standards belong to the highest degree of accuracy. Accuracy requirements in various routine measurements are totally dependent on the particular measurement applications.

2.3 ORGANISATION OF THE MEASUREMENT SERVICE

The Finnish Measurement Service is from its organisational principle similar to the metrological systems in most European industrialised countries (Fig. 2). Its most essential duty is to arrange the traceability chains from the measuring instruments of the end users to the SI unit system.

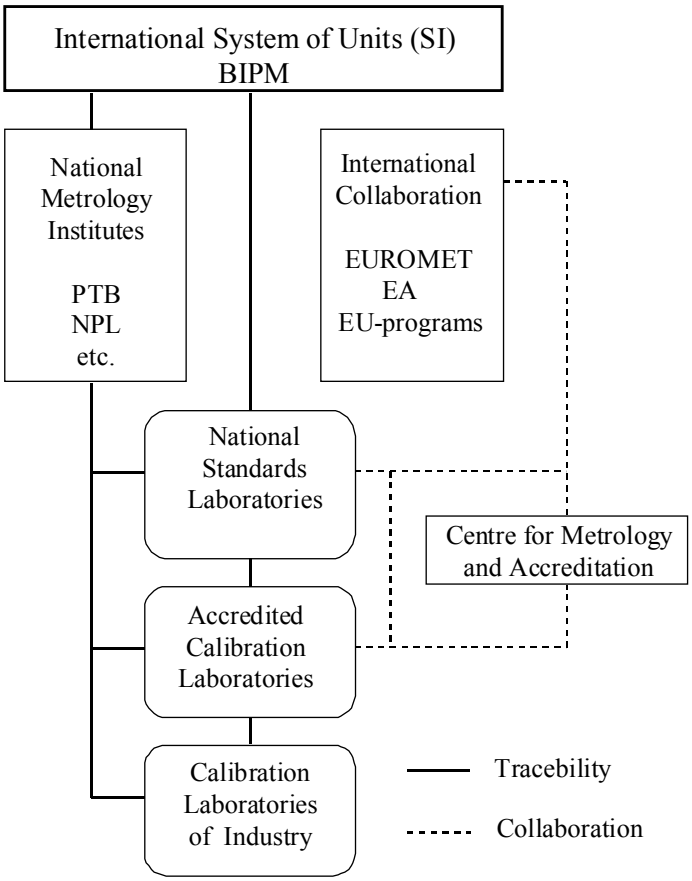


Fig. 2. Traceability to SI-units and collaboration concerning calibration activities.

The Centre for Metrology and Accreditation (MIKES), subordinated to the Ministry of Trade and Industry, is the co-ordinating national body of the Measurement Service. The Finnish National Measurement Standards System is a decentralised system, in which a number of research institutes act as National Standards Laboratories. The laboratories are responsible for the maintenance and development of the National Measurement Standards. MIKES designates the National Standards Laboratories and supervises their operations. Financing and international co-operation are also channelled through MIKES.

In the beginning of the year 2000 the activities of the National Standards Laboratories of the Technical Research Centre of Finland (VTT) were transferred to MIKES. The National

Standards Laboratory for electrical quantities, time and frequency maintained by VTT Automation and the National Standards Laboratory for dimensional quantities maintained by VTT Manufacturing Technology were administratively amalgamated to MIKES. Thus, MIKES currently has National Standards Laboratories for mass, pressure, temperature, humidity, length, dimensional quantities, electrical quantities, and time and frequency (Fig. 3). The acoustics laboratory does not have the status of a National Standard Laboratory yet. The Helsinki University of Technology (HUT) is the National Standards Laboratory for optical quantities and high voltage measurements. The Finnish Geodetic Institute (FGI) is the National Standards Laboratory for acceleration of free fall and length according to its own legislation. In accordance with a separate Decree, the Radiation and Nuclear Safety Authority (STUK) is responsible for maintaining measurement standards for ionising radiation. The National Standards Laboratories are presented in Fig. 4.

Metrology Department of MIKES Heikki Isotalo				
Mass	**Temperature**	**Length**	**Electricity**	**Assistance**
Kari Riski (team leader) Markku Rantanen Heikki Kajastie Jorma Manninen	Thua Weckström (team leader) Martti Heinonen Hannu Räsänen	Antti Lassila (team leader) Heikki Lehto Veli-Pekka Esala Björn Hemming Raimo Mylläri Kaj Nyholm Ilkka Palosuo Ilkka Raeluoto Asko Rantanen Jarkko Unkuri	Panu Helistö (team leader) Pekka Immonen Kalevi Kalliomäki Tapio Mansten Kari Ojasalo Risto Rajala Aleksandre Satrapinski	Jaana Järvinen Seppo Nevalainen Kirsi Tuomisto
Mass laboratory Kari Riski * **Pressure laboratory** Markku Rantanen *	**Thermometry laboratory** Thua Weckström * **Humidity laboratory** Martti Heinonen *	**Length laboratory** Antti Lassila * **Dimensional quantities of engineering works** Heikki Lehto *	**Electricity laboratory** Panu Helistö * **Time and frequency laboratory** Kalevi Kalliomäki * **Acoustics laboratory** Panu Helistö *	

* head of the laboratory

Fig. 3. Organisation of the Metrology Department of MIKES, 2 April 2001.

In Addition, there are Accredited Calibration Laboratories for measurement quantities for which there are no National Standards Laboratories. MIKES has made a contract with Tampere University of Technology (coordinate measurements) and Raute Precision Oy (force and torque) that they produce expert services, e.g., maintenance of traceability of their reference standards, guidance of industrial customers, international co-operation and organising of comparisons. The Contract Laboratories are presented in Fig. 5.

MITTATEKNIIKAN KESKUS
CENTRE FOR METROLOGY AND ACCREDITATION

FINNISH NATIONAL STANDARDS LABORATORIES 31.12.2000

Kansallinen mittanormaalilaboratorio • FINMET •

NATIONAL STANDARDS LABORATORY	QUANTITIES	HEAD OF LABORATORY	e-mail
Centre for Metrology and Accreditation POB 239, FIN-00181 Helsinki Tel. 358 9 616 761* Fax 358 9 6167 467	mass pressure length[1] temperature humidity	Kari Riski Markku Rantanen Antti Lassila Thua Weckström Martti Heinonen	kari.riski@mikes.fi markku.rantanen@mikes.fi antti.lassila@mikes.fi thua.weckstrom@mikes.fi martti.heinonen@mikes.fi
Centre for Metrology and Accreditation Otakaari 7 B FIN-02150 ESPOO Tel. 358 9 4561* Fax 358 9 456 7029	electric voltage (dc and ac) electric current (dc and ac) electric power and energy (dc and ac), resistance, capacitance time interval, frequency instant of time	Panu Helistö	panu.helisto@mikes.fi
Centre for Metrology and Accreditation Metallimiehenkuja 6 FIN-02150 ESPOO Tel. 358 9 4561* Fax 358 9 460 627	length, angle flatness, straightness roundness, cylindricity surface roughness	Heikki Lehto	heikki.lehto@mikes.fi
Helsinki University of Technology High Voltage Institute POB 3000, FIN-02015 HUT Tel. 358 9 4511* Fax 358 9 451 2395	dc voltage, ac voltage (50 Hz) capacitance (50 Hz), loss factor inductance (high voltage reactors) lightning impulse voltage switching impulse voltage, other impulse voltages, impulse current impulse energy, impulse charge	Martti Aro	martti.aro@hut.fi
Helsinki University of Technology Metrology Research Institute POB 3000, FIN-02015 HUT Tel. 358 9 4511* Fax 358 9 451 2222	luminous intensity, illuminance luminance, spectral irradiance spectral radiance, colour coordinates, colour temperature optical power, transmittance, reflectance, spectral responsivity optical wavelength	Erkki Ikonen	erkki.ikonen@hut.fi

[1] Lasers, long gauge blocks and line scales

Positions of Finnish Geodetic Institute and Radiation and Nuclear Safety Authority are based on the relevant legislation.

Finnish Geodetic Institute Geodeetinrinne 2 FIN-02430 Masala Tel. 358 9 295 550* Fax 358 9 2955 5200	acceleration of free fall length	Jussi Kääriäinen	jussi.kaariainen@fgi.fi jorma.jokela@fgi.fi jaakko.makinen@fgi.fi
Radiation and Nuclear Safety Authority (STUK) POB 14, FIN-00881 Helsinki Tel. 358 9 759 881* Fax 358 9 7598 8450	air kerma, reference air kerma rate absorbed dose to water, ambient dose equivalent, directional dose equivalent, personal dose equivalent, surface emission rate	Hannu Järvinen	hannu.jarvinen@stuk.fi

Fig. 4. The National Standards Laboratories of Finland.

MITTATEKNIIKAN KESKUS
CENTRE FOR METROLOGY
AND ACCREDITATION

CONTRACT LABORATORIES 31.12.2000

CONTRACT LABORATORY	QUANTITIES	HEAD OF LABORATORY	e-mail
Raute Precision Oy Force and Mass Laboratory POB 22, FIN-15801 Lahti Tel. 358 3 829 4275 Fax 358 3 829 4101	force, torque	Aimo Pusa	aimo.pusa@rauteprecision.fi
Tampere University of Technology Institute of Production Engineering POB 589, FIN-33101 Tampere Tel. 358 3 365 2719 Fax 358 3 365 2753	coordinate measurement coordinate measuring machines	Heikki Tikka	heikki.tikka@pe.tut.fi

Fig 5. The Contract Laboratories.

The Advisory Commission for Metrology, appointed by the Council of State, acts as an expert body in an advisory capacity. The Commission is divided into three sections: Measurement Service, Verification and Chemical Metrology. In addition, a number of expert working groups operate under these sections. Regarding the Measurement Service Section there are working groups corresponding to various quantity groups, i.e., mass, electricity/time, length, temperature, radiometry and photometry, flow and acoustics.

The Accredited Calibration Laboratories offer calibration services directly to the end users. The calibration certificates given by them belong to the scope of the multilateral agreement of the organisation for the European co-operation for Accreditation (EA). The Finnish Accredited Calibration Laboratories can be found on the Internet pages of MIKES, www.mikes.fi/finas.

Legal metrology or verification is also closely connected with the field of the National Measurement Service. The primary scope of verification in Finland is focused on the measures and measuring instruments used in commercial transactions. The Safety Technology Authority (TUKES) is the national authority that supervises and controls the field of legal metrology and contributes to the drafting of relevant legislation.

2.4 INTERNATIONAL CO-OPERATION

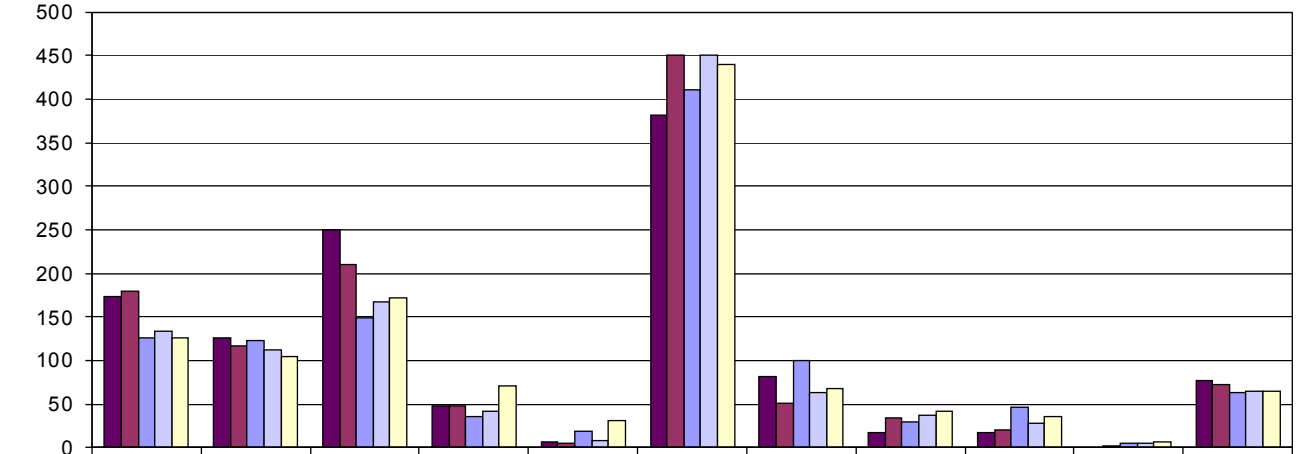
MIKES is responsible for the general international co-operation concerning the Measurement Service and metrology. In addition, the National Standards Laboratories take care of the international connections in their special areas. Intercomparisons of National Measurement Standards of different countries are an essential means of co-operation, through which the international competency and consistence can be shown.

The principal forums of co-operation are: CGPM/CIPM/BIPM based on the Metre Convention, EUROMET collaboration between the European National Metrology Institutes, and EA. In legal metrology the main organisations are WELMEC, for European co-operation and OIML, for international co-operation.

At a meeting held in Paris on 14 October 1999, the directors of the National Metrology Institutes (NMIs) of thirty-eight Member States of Metre Convention – including MIKES – signed a mutual recognition arrangement (MRA) drawn up by the CIPM, related to national measurement standards and calibration and measurement certificates issued by NMIs. The technical basis of the MRA is a set of key comparisons of national measurement standards identified by the Consultative Committees of the CIPM and executed at the highest level by the BIPM, the Consultative Committees and the regional metrology organisations. NMIs should have quality systems and demonstrations of competence. The outcome of the MRA is a database which includes statements of the measurement capabilities of each NMI. The database will be publicly available on the Internet. The text of the MRA is available on the BIPM Internet page, www.bipm.fr.

3. ACTIVITIES OF THE NATIONAL STANDARDS LABORATORIES IN 2000

3.1 CALIBRATIONS



	Mass	Pressure	Tempera-ture	Humidity	Length	Dimensio	Electricity, time	Optics - HUT	High voltage - HUT	Length, g - FGI	Ionising radiation - STUK
1996	174	126	250	49	7	383	82	17	17		76
1997	180	116	210	48	5	452	52	34	21	2	72
1998	126	124	149	35	19	410	100	29	47	4	63
1999	134	112	167	41	9	450	63	37	28	4	65
2000	127	104	172	70	31	440	67	41	35	7	65

Fig. 6. The number of calibration certificates issued by National Standards Laboratories.

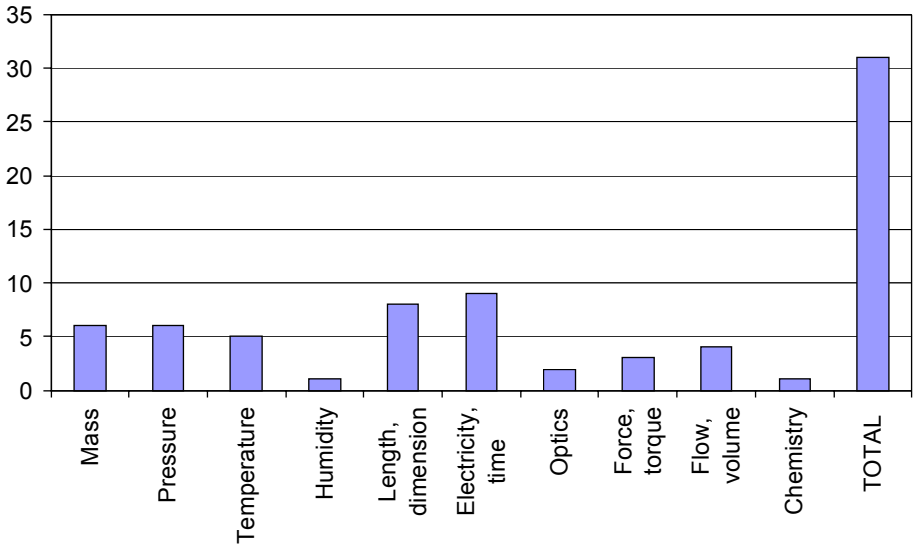
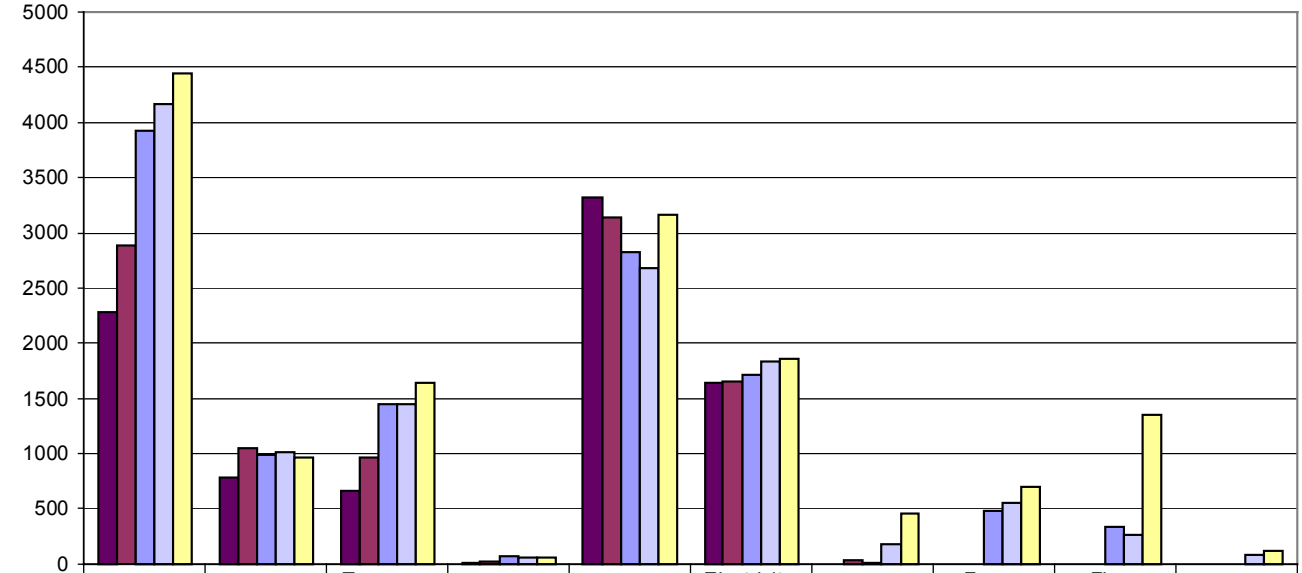


Fig. 7. The number of Accredited Calibration Laboratories in 2000.
Some laboratories are operating in several different fields.



	Mass	Pressure	Tempera-ture	Humidity	Length	Electricity, time	Optics	Force, torque	Flow, volume	Chemistry
1996	2276	788	657	10	3314	1644				
1997	2887	1043	963	18	3135	1654	32			
1998	3920	985	1449	70	2823	1713	4	476	342	
1999	4168	1018	1444	61	2675	1836	182	550	265	86
2000	4449	967	1641	63	3159	1864	460	699	1348	115

Fig. 8. The number of calibration certificates issued by the Accredited Calibration Laboratories.

3.2 INTERNATIONAL COMPARISONS

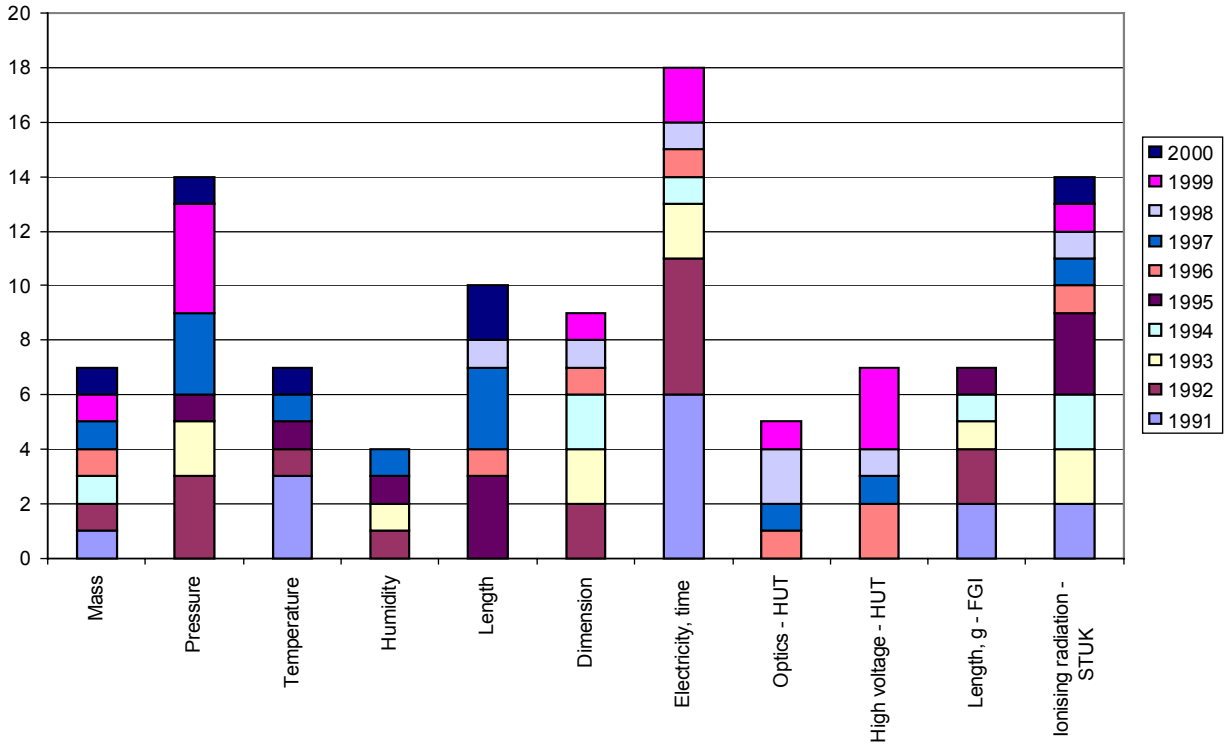


Fig 9. The number of international comparisons participated by National Standards Laboratories. The year refers to the publishing date of the final report.

3.3 PARTICIPATION IN THE EUROMET-PROJECTS

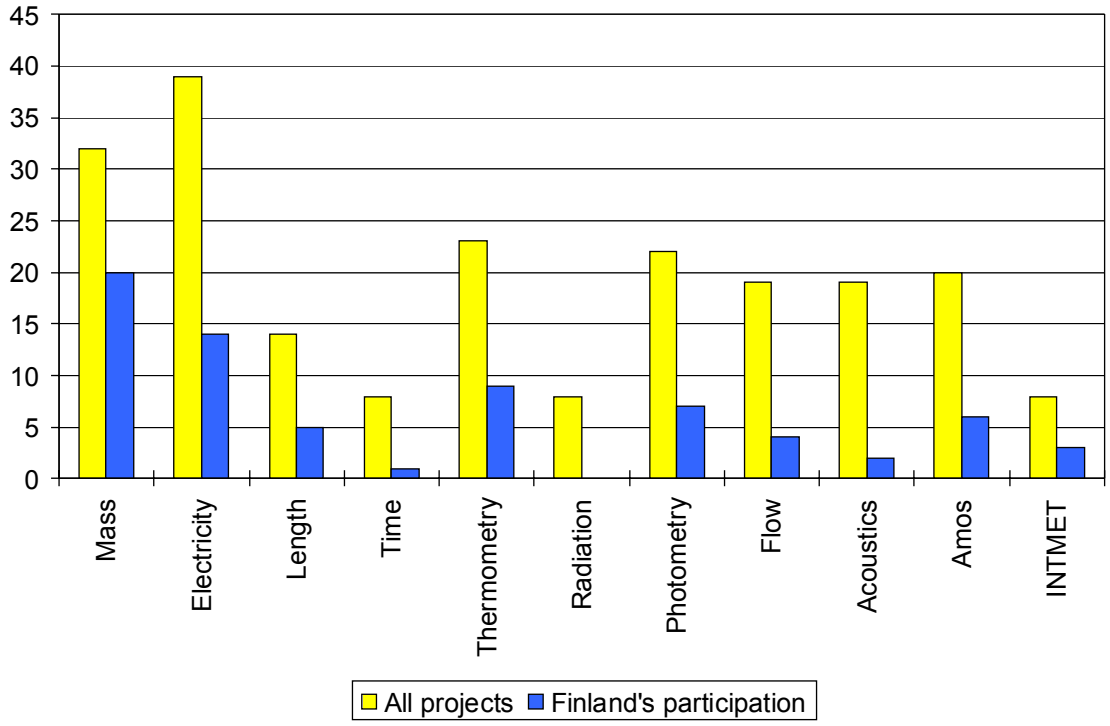


Fig. 10. The number of agreed and proposed EUROMET projects of various quantity groups, March/2001 [1].

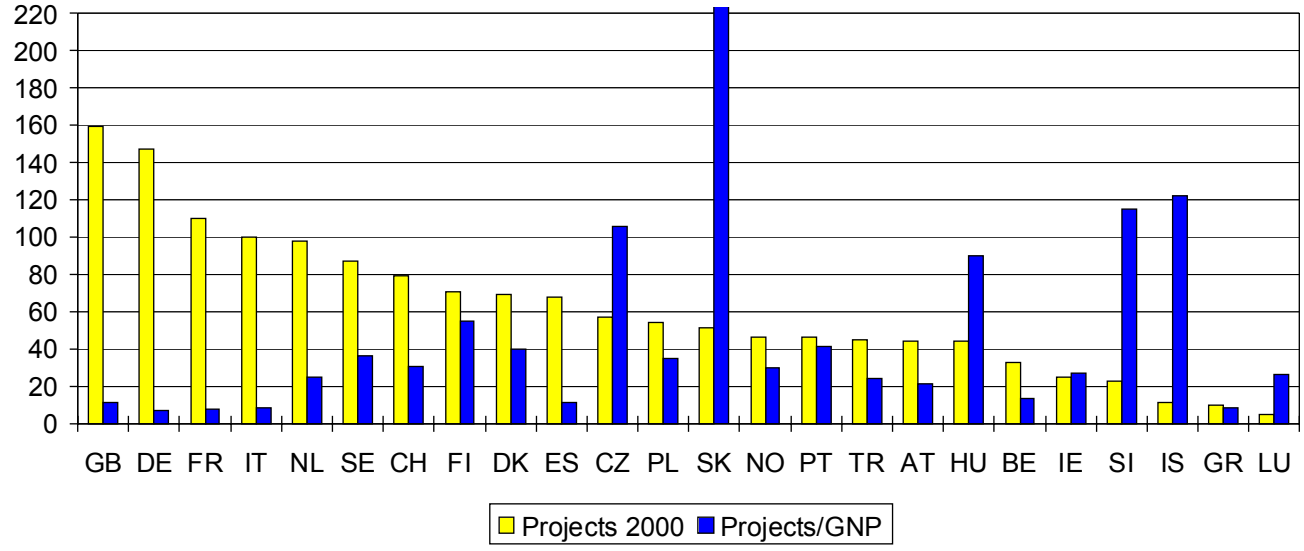


Fig. 11. The number of agreed and proposed EUROMET projects of various countries participated in, and the number of projects per Gross National Product (GNP) of the country, March/2001 [1].

List of country abbreviations:

AT	Austria	ES	Spain	IE	Ireland	PL	Poland
BE	Belgium	FI	Finland	IS	Iceland	PT	Portugal
CH	Switzerland	FR	France	IT	Italy	SE	Sweden
CZ	Czech Republic	GB	United Kingdom	LU	Luxembourg	SI	Slovenia
DE	Germany	GR	Greece	NL	Netherlands	SK	Slovakia
DK	Denmark	HU	Hungary	NO	Norway	TR	Turkey

Reference:

1 The Internet pages of EUROMET, www.euromet.org, cited 12 March 2001.

3.4 DEVELOPMENT PROJECTS

ELECTRICITY	
MIKES:	Development of Resistance Metrology in 2000
	Extension of the Range of the AC Power and Current Measurements
	Development of Calibration Service for Small AC Voltages
	Development of AC Current Step-up Set-up
	Tracing of Working Standards for AC Voltage and Current
	Development of High Frequency and Acoustics Metrology in 2000
HUT HVI:	Development of National Measurement Systems for Voltage and Current Impulse Quantities
	Development of National Measurement Systems for High-Voltage DC and AC Quantities
	Additional Development of High-Voltage DC, AC and Impulse Metrology
LENGTH	
MIKES:	Iodine Stabilised Diode Laser
	Calibration Facility for Thermal Expansion Coefficient
	Iodine Stabilised Nd:YAG Laser
	2D Optics
	Measurement of Temperature of Air in Real-time in Laser Measurements
	Calibration Facilities for Optical Flats
	Improving the Facilities for Calibration of Laser-interferometers
	Compensation of the Temperature Differences in SIP Length Measuring Machine
OPTICS	
HUT MRI:	Development Project of Optical Quantities:
	Realisation of the Luminous Flux Unit Using an Absolute Integrating Sphere Method
	Calibration Facility for Spectral Diffuse Reflectance
	Calibration Facility for Fibre Optic Power Meters
	A New Technique for the Measurement of Irradiance Responsivity of Filter Radiometers
MASS	
MIKES:	Traceability for Pressure Measurements in Vacuum
	Traceability for Pressure Measurements
	Realisation of the kilogram with Electrical Quantities
TEMPERATURE	
MIKES:	Development of the Humidity Standards
	Replacement of the Calibration Furnaces
CONTRACT LABORATORIES	
Raute (ACL):	Key Comparison for 0 – 10 kN
	Expert Services (force and torque measurements)
TUT (ACL):	Expert Services (coordinate measuring machines)
OTHER SUPPORT	
TUT:	Co-ordination of Flow Calibrations
ACLs:	Support to ACLs which operate without services of NSL

Fig. 12. Development projects in 2000. The table does not include the projects of the Finnish Geodetic Institute and the Radiation and Nuclear Safety Authority. MIKES funded the maintenance and development projects with ca. 13 million FIM (2.2 million EUR).

3.5 CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) MASS LABORATORY

QUANTITIES

Mass
Density

PERSONNEL

Kari Riski	Senior Research Scientist, Head of the Laboratory
Martti Heinonen	Senior Research Scientist
Heikki Kajastie	Research Scientist
Jorma Manninen	Laboratory Engineer
Markku Rantanen	Senior Research Scientist
Hannu Räsänen	Research Assistant

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

The national standard of mass is the Pt-Ir prototype kilogram No 23. Secondary kilograms were compared with the prototype kilogram. A systematic decrease of about 30 µg in the masses of the secondary kilograms from previous calibration was observed. The mass of the prototype kilogram had increased. The prototype kilogram was carried to BIPM. Measurement at BIPM showed that the mass had increased 54 µg from the previous calibration in 1990. To remove excess surface contamination the kilogram will be cleaned and calibrated.

Maintenance

Secondary kilograms have been calibrated. The mass scale in the range 1 mg – 100 g has been established. A new transport case for the prototype kilogram has been made. A new mass comparator Sartorius CC6 has been taken into use. Hydrostatic weighing instruments have been checked with silicon density standards. Video monitoring of liquid level in hydrometers calibrations has been tested.

Development

Realisation of the kilogram
The purpose of the project is to define the unit of mass (kilogram) in terms of other quantities. Superconducting magnetic levitation method will be used. The present stage of the project contains preliminary investigations. A study of the superconducting properties of Niobium has been made. A plan to determine possible energy losses in superconductors by the calorimetric method has been made. Different shapes for the levitated body and for the coil which produces the levitating magnetic field and have been investigated. The project has been made in co-operation with VNIIM (Russia), VTT Automation and University of Jyväskylä.

Development of a silicon based micro-balance
The project has been made in co-operation with VTT Automation. The aim of the project is to make a prototype balance from a single silicon chip. The first version of the balance has been manufactured. Preliminary tests show that the repeatability of the balance at 1 g will be about 3 µg.

Intercomparisons

International comparisons

A comparison of the volume and mass of a ceramic sphere has been made. This is an extension to EUROMET 339 "Intercomparison of volume standards by hydrostatic weighing". Twelve laboratories took part to the original comparison. For MIKES the E_n value for volume was –0.2 when using water as the density reference. The E_n value for mass was –2.0. The discrepancy in mass is probably due to static electricity. Because the relative uncertainty of mass is smaller than the relative uncertainty of volume the discrepancy in mass does not significantly affect the volume results.

International (EA or other) intercomparisons for accredited calibration laboratories

National intercomparisons for accredited calibration laboratories

A comparison of 1 kg and 10 kg weights (M3) has been completed. Three accredited calibration laboratories were participating the comparison. The E_n values of all laboratories were less than 1.

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

S. Lorefice, M. Heinonen, T. Madec: Bilateral comparison of hydrometers calibrations between the IMGC-LNE and the IMGC-MIKES, Metrologia 37 (2000) 141-147.

Conferences

Aarne Oja, Teuvo Sillanpää, Hannu Sipola, Heikki Seppä, Jyrki Kiihamäki, Pekka Seppälä, Jani Karttunen and Kari Riski: Micromechanical Silicon Precision Scale, Proceedings of an international conference on Microfabrication, Integration and Packing, SPIE, 9-11 May 2000, Paris, France.

Reports

Intercomparison reports

Kari Riski: Mass comparison M3, Julkaisu J3/2000, Mittatekniikan keskus.

Kari Riski: Mass and volume comparisons at MIKES, Julkaisu J4/2000, Mittatekniikan keskus.

Lectures

Kari Riski: Akkreditoinnin vaatimukset mittaustulosten luotettavuudelle; Mittausepävarmuus, analyysimittaukset, AEL, 31 March 2000 (in Finnish).

Kari Riski: Punnukset, vaa'at ja dimensiomittaukset, Laboratoriolaitteiden kalibrointi ja laadussapito; AEL, 15 May and 11 October 2000 (in Finnish).

Kari Riski: Punnusten ja vaakojen kalibrointi; Mittaus 2000, Suomen Automaatioseura ry, 9-10 May 2000 (in Finnish).

Kari Riski: Kalibrointipalvelujen saatavuus ja jäljitettävyyden hankkiminen - Mittatekniikan keskuksen palvelut, Kalibroinnit ja laatujärjestelmät, 28 November 2000 (in Finnish).

Other activities

Visits

Kari Riski and Heikki Kajastie participated in EUROMET Mass Contact Persons Meeting and Mass and Density project meetings, 14-18 February 2000 at MIKES.

Jorma Manninen and Heikki Kajastie visited VNIIM, Russia, 2-3 March 2000.

Kari Riski visited BIPM, Paris, 4 October 2000.

Martti Heinonen participated in reference group meeting of Nordtest-project 1475-99 ("Evaluation of field calibration technique for density meters"), FIMAS, Bergen, 30 March 2000.

Visitors

E.T. Frantsuz and V.M. Khavinson, VNIIM, 3-7 April 2000.

E.T. Frantsuz, VNIIM, 9 October to 7 November 2000, (Realisation of the kilogram project).

Memberships

Kari Riski, Advisory Commission for Metrology, expert group for mass quantities.

Kari Riski, EUROMET Contact person for mass.

CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) PRESSURE LABORATORY

QUANTITIES

Pressure

PERSONNEL

Markku Rantanen	Senior Research Scientist, Head of the Laboratory
Jorma Manninen	Laboratory Engineer

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

In the range from 1 kPa to 500 MPa the unit of pressure is realised using a set of pressure balances. The effective areas are traceable to BNM-LNE, France. The BNM-LNE results are completed with dimensional measurements by the MIKES Length laboratory on two 35 mm diameter piston cylinder units.

Maintenance

In 2000, two piston/cylinder units were calibrated at BNM-LNE, one for the range from 0.5 MPa to 50 MPa and the other for the range 20 kPa to 1000 kPa. The capacitance manometres for the ranges 0 to 130 Pa and 0 to 1300 Pa were calibrated at MKS, Germany, in April 2000.

Development

Traceability of low absolute pressures
A series of measurements were made in order to derive the traceability for absolute pressures from differential pressure measurements. Three capacitance manometers for differential pressure were at first calibrated between two pressure balances with a relatively high line pressure. Then the differential pressure gauges were used with very low line pressure as standards in calibrating three capacitance manometers. The uncertainty of the results, however, was not as low as expected, probably due to the line pressure effects and the instability of the capacitance manometers.

Intercomparisons

International comparisons

The final report on the EUROMET key comparison in the oil pressure range up to 100 MPa was published in April 2000 (M. Perkin: Report on a comparison of pressure standards in the range 10 MPa to 100 MPa. NPL report CMAM 54). The measurements in MIKES were made in 1997. The maximum relative deviation of MIKES results from the reference value was $1.47 \cdot 10^{-5}$, with an uncertainty of the result $3.08 \cdot 10^{-5}$.

The MIKES measurements in the EUROMET key comparison for absolute pressure range from 0.1 Pa to 1000 Pa (project #442) were performed in August and September in 1999.
Another EUROMET key comparison (project #439) in gauge pressure range 0.08 MPa to 7 MPa was participated in September and October 2000.

The measurements in a bilateral comparison between MIKES and SP/Sweden on gauge pressure ranges 1 MPa to 50 MPa and 5 kPa to 13 kPa. The report will be published in 2001.
Measurements in absolute pressure comparison between MIKES and SMU/Slovakia in the range 0.05 MPa to 0.35

MPa were made in May 2000. The pressure laboratories of Vaisala Oy and SP/Sweden will join in the comparison in 2001.

The final report on the EUROMET project #455 (intercomparison in the pressure range 50 kPa to 350 kPa) is being prepared and will be published in early 2001. Participants in this project are MIKES, CMI/CZ, NMi/NL, CEM/ES, SP/SE and JV/NO. The measurements were made in 1997 – 2000.

International (EA or other) intercomparisons for accredited calibration laboratories

One of the Finnish accredited pressure laboratories participated in an absolute pressure comparison EA-Pr8 in the range 0.1 to 3000 Pa.

National intercomparisons for accredited calibration laboratories

MIKES arranged an intecomparison N2/P13 for the Finnish accredited laboratories in the gauge pressure range 0 to 2 MPa. In addition to the Finnish laboratories, six laboratories from Denmark, Estonia and Sweden joined in. The results from all the laboratories were within the stated uncertainties, but there was a large variation in the measurement methods. (M. Rantanen: Nordic intercomparison in gauge pressure range 0…2 MPa. Julkaisu J6/2000, MIKES).

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications
Conferences
Reports

Intercomparison reports

M. Rantanen: Nordic intercomparison in gauge pressure range 0 … 2 MPa. Julkaisu J6/2000, MIKES.

Lectures

M. Rantanen: Painemittareiden kalibrointi. AEL-INSKO, Kalibrointi – tarve ja suoritus käytännössä. 16th April 2000, Lahti (in Finnish).

M. Rantanen: Paineen mittauskyky Suomessa, ongelma-alueet ja tulevaisuuden näkymät. Mittaus 2000 (Measurement 2000) seminar, 10 May 2000, Helsinki (in Finnish).

Other activities

In addition to the EUROMET projects mentioned above, MIKES participated in #499: bulletin board on concerns, problems and experiences.

M. Rantanen participated in the EUROMET Mass Contact Persons Meeting in Helsinki 14 – 18 February, and in EUROMET discussion meeting on CMC tables in pressure and vacuum in London 4-5 December.

M. Rantanen participated in a meeting for Nordic pressure laboratories at SP, Borås, Sweden 20 – 21 March.

M. Rantanen participated 5th September in a course on pressure measurements (Tryckmätning i laboratorium och produktion), Stockholm, Sweden, arranged by SP.

Visitors from other pressure laboratories: Participants of the EUROMET Mass Contact Persons Meeting 14 – 18 February, Jukka IsoPahkala and Fredrik Langmead from SP, Sweden, on 18 April and P. Farar from SMU, Slovakia, 15 – 19 May.

M. Rantanen visited in 2000 three pressure laboratories in other countries: Metrosert, Estonia 12 July, SP, Sweden 5 – 6 August and DH Instruments, Phoenix, USA, 24 – 27 October.

M. Rantanen is a secretary in the Expert Group on Mass and Derived Quantities of the Advisory Commission for Metrology in Finland.

CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) THERMOMETRY LABORATORY

QUANTITIES

Temperature

PERSONNEL

Thua Weckström	Senior Research Scientist, Head of the Laboratory
Hannu Räsänen	Research Assistant

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

Realisation of the International Temperature Scale of 1990 (ITS-90) between the Argon point (-189.3442 °C) and the silver point (961.78 °C).

Maintenance

The reference pyrometer (IKE LP") and two new S-type noble metal thermocouples were calibrated.

Development

Replacement of the calibration furnaces
Within this project the old furnaces in the laboratory are replaced by new ones with heat-pipes. The second furnace (Isotech Sodium Heat-Pipe Furnace) has been tested with a fixed point cell and a thermometer coupled to the bridge. The electrical noise that is present when using the old furnaces is now removed.

Closed fixed point cells
The laboratory has recently had trouble with the open fixed point cells, as the vacuum system for evacuation of the cells has not been working as it should. Thus, a closed Aluminium cell has been purchased from Isotech LTD. It has not yet been used.

Surface thermometers
The heat-plate device for calibrating surface thermometers has been tested, and some types of surface thermometers have been tested. The device can now be used for the calibration of surface thermometers from ambient temperature up to 300 °C.

Intercomparisons

International comparisons

In the EU Framework IV TRIRAT-project the radiation temperature of the low-temperature blackbody radiators (2 BBRs) were measured with two low-temperature infrared thermometers and 3 BBRs in the medium range were measured with two medium-range infrared thermometers.

The reference pyrometer of the laboratory is compared with the key-comparison calibrations lamps (EUROMET project 412).

International (EA or other) intercomparisons for accredited calibration laboratories

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications
Conferences
Reports

Intercomparison reports

T. Weckström, Intercomparison of temperature standards of Lithuania and Finland, Mittatekniikan keskuksen julkaisu J1/2000.

Lectures

Other activities

T. Weckström participated in the EUROMET meeting of contact persons for Thermometry 26-29 March 2000 at SMU in Bratislava, Slovakia and in the EA Temperature and Humidity Experts Group meeting 7-8 September 2000 at INTA, Madrid, Spain.

T. Weckström is the secretary of the Expert Group on Temperature and Derived Quantities of the Advisory Commission for Metrology in Finland. The group is preparing a guidance document for measuring temperatures.

CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) HUMIDITY LABORATORY

QUANTITIES

Dew-point temperature
Relative humidity

PERSONNEL

Martti Heinonen	Senior Research Scientist, Head of the Laboratory
Hannu Räsänen	Research Assistant
Tomi Blomqvist	Trainee, 1 January – 31 March 2000
Raine Lampio	Trainee, 22 May – 23 August 2000

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

The dew-point temperature scale and the relative humidity scale are realised using a two-temperature generator system.

Maintenance

A new dew-point generator has been developed and compared with the national standard. The quality system was developed further to meet better the demands of the current activities in the laboratory and the EN ISO/IEC 17025 standard. The effect of pressure on the dew-point temperature was studied and a new calculation method was derived.

Development

Development of comparison methods for humidity
An improved prototype of a dew-point comparator was constructed. Tests on the system will be completed in 2001. An investigation on chilled mirror hygrometers was started in autumn 2000 and it is carried out in co-operation with Industrial Research Ltd (New Zealand) and Vaisala Oyj.

Intercomparisons

International comparisons

EUROMET 511: Intercomparison of Humidity Generators. MIKES is the coordinator and the pilot laboratory of the comparison. Other participants are: Russia, PL, DK, GB, CH, TR. All other countries except Russia and MIKES have completed their measurements. The transfer standard has been calibrated five times at MIKES. The measurements cover the dew-point temperature range from –60 °C to +75 °C. The project will be completed in March 2001. According to the results reported in an intermediate report on the first phase of the project, the transfer standard is stable enough but the reliability of the results at the lowest point (-60 °C) is poorer than at other points.

International (EA or other) intercomparisons for accredited calibration laboratories

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications
Conferences

Reports

M. Heinonen, Kosteusmittarit ja niiden kalibrointi, kurssimateriaali, MIKES, May 2000, 74 p.

M. Heinonen, Kosteusmittarit ja niiden kalibrointi, kurssimateriaali, MIKES, September 2000, 92 p.

M. Heinonen, MSPG:n epäideaalisuus, Report MHL 4/00, MIKES 2000, 6 p.

M. Heinonen, Kaasun kosteuden mittaaminen, to be published.

Intercomparison reports

M. Heinonen, EUROMET 511 – Intercomparison of Humidity Generators, Intermediate Report, MIKES, May 2000, 26 p.

M. Heinonen, RH/T-mittarin kalibrointia koskeva vertailumittaus, Report MHL 1/00, MIKES 2000, 8 p.

M. Heinonen, Kylläisten suolaliuosten kalibrointia koskeva vertailumittaus, Report MHL 2/00, MIKES 2000, 10 p.

M. Heinonen, Kosteuslaskentaa koskeva vertailu, Report MHL 3/00, MIKES 2000, 7 p.

Lectures

M. Heinonen, Haasteena luotettavuus kosteusmittauksissa, Mittaus 2000 -seminaari, 10 May 2000.

M. Heinonen, Kosteusmittarit ja niiden kalibrointi –kurssi, MIKES, 23-24 May 2000.

M. Heinonen, Kosteusmittarit ja niiden kalibrointi –kurssi, MIKES, 19-20 September 2000.

M. Heinonen, Arviointikohteena laitteisto ja mittausten jäljitettävyys, Täydennyskoulutus arvioijakurssin käyneille, FINAS, 12 December 2000.

Other activities

M. Heinonen is a member of the Expert Group on Temperature Measurements, Advisory Commission for Metrology.

M. Heinonen is a member of the working group 5 (CMC tables, humidity) of the EUROMET/THERM.

M. Heinonen acted as a referee for the Measurement Science and Technology.

M. Heinonen acted as a referee for the International Journal of Food Science and Technology.

M. Heinonen participated in three meetings of the planning committee of the AEL-INSKO training course on humidity measurements in process industry.

The following persons visited the laboratory

E. Frantsuz and V. Khavinson, VNIIM, Russia, 7 April 2000.

Dr Vitushkin, BIPM, 5 October 2000.

The laboratory personnel made the following visits

M. Heinonen, Justervesenet, Norway 29 March 2000.

M. Heinonen, Kongsberg FIMAS, 30 March 2000.

CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) LENGTH LABORATORY

QUANTITIES

Length

PERSONNEL OF THE LABORATORY

Antti Lassila	Senior Research Scientist, Head of the Laboratory
Kaj Nyholm	Senior research Scientist
Jarkko Unkuri	Research Scientist
Jie Xu	Guest researcher from National Institute for Metrology, China, until 31.3.2000.

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

The Finnish primary standard for length is realised by three iodine stabilised 633 nm helium-neon lasers operated according to the recommendations given by CGPM and CIPM. The expanded uncertainty of the realisation is $5 \cdot 10^{-11}$. In addition the metre is realised at 543.5 nm wavelength with two iodine stabilised green He-Ne lasers. These lasers form the basis for traceable length measurements in Finland.

Maintenance

The iodine stabilised lasers at 633 nm and 543.5 nm have been maintained in the qualified conditions. The correct operation of the lasers is ensured by regular participation in international comparisons. The calibration service at 543.5 nm was started. Interferometers for calibration of long gauge blocks and line scales have been maintained in operation condition.

The quality manual of the length laboratory was updated to follow ISO/IEC 17025. Several measurement instruction for calibration of different measuring instruments on 30 m interferometric measurement rail were composed. The length laboratory will offer more actively calibrations on the 30 m rail in future.

Development

Development of an iodine-stabilised diode laser at 633 nm
An iodine-stabilised external-cavity diode laser utilising a transmission grating was constructed in a jointly project of MIKES and HUT. The results achieved show that the diode laser can reach similar or even better stability than iodine-stabilised He-Ne -lasers at 633 nm. A detailed description of the laser system and results of the stability and repeatability measurements as well as studies on the dependency of the laser frequency on operational parameters can be found in a conference paper presented in CPEM and in an article submitted to Metrologia.

Development of an iodine-stabilised Nd:YAG laser at 532 nm
A diode-pumped Nd:YAG laser at 532 nm was frequency-stabilised to iodine absorption lines. The system is based on a commercial diode-pumped frequency-doubled Nd:YAG laser with monolithic non-planar ring oscillator. Electronics was constructed and the optical setup put together for the stabilisation with third-harmonic locking technique. In preliminary measurements, several absorption lines of iodine were identified and the frequency of the laser was successfully locked on the hyperfine components.

Development of a calibration service for quartz meters

In a co-operation project of MIKES, FGI (Finnish Geodetic Institute) and NIM (National Institute of Metrology, China) a method for calibration of quartz bars have been established. A standard uncertainty of 36 nm has been achieved in calibrations of 1-m quartz bars. This calibration service allows continuation of baseline measurements with Väisälä interferometer by Finnish Geodetic Institute. In 2000 several test measurements were made for checking the reliability of operation and the calibration service was started by calibrating 4 quartz bars.

Development of calibration of linear displacement at nanometric scale
Properties of a 21-bit digital piezo transducer (DPT) system has been studied and it has been calibrated by a laser interferometer. A measurement program for DPT has also been drawn up. The DPT has been used to study non-linearities of laser interferometer, gauge block interferometer and optical surface roughness measuring device.

Development of device for thermal expansion measurements
A project has been started by designing vacuum chamber; radiation shield; control electronics and heating/cooling elements. The artefact will situate inside the radiation shield on a temperature controlled base. The length changes will be measured by existing gauge block interferometer.

Intercomparisons

International comparisons

Euromet project 413: Phase correction measurements in gauge block metrology. A final report has been published: Leach R.K., Hart A., International Comparison: Interlaboratory comparison of measurements of the phase correction in the field of gauge block interferometry, Metrologia 37 (2000) 261-267. The results of MIKES had slight offset of -8 nm to the mean of the comparison. The offset was in agreement with estimated uncertainty.

Euromet project 462: Intercomparison of $^{127}I_2$ stabilised 633 nm He-Ne lasers locked by 5th harmonic method (BIPM, CMI, VNIIM, NIM and MIKES). Measurements were carried out 1998. Final report is accepted for publication in Metrologia.

An international comparison of diode lasers stabilised on $^{127}I_2$ at λ=633 nm was carried out at BIPM in January 1999. The comparison report has been published: Zarka A. et al., International comparison of eight semiconductor lasers stabilized on $^{127}I_2$ at lambda = 633 nm, Metrologia 37 (2000) 329-339.

A bilateral comparison of frequencies of the iodine stabilised 543.5 nm He-Ne lasers of DFM and MIKES was carried out at Denmark in December 1999. The final report is accepted for publication in Metrologia.

A bilateral comparison of iodine-stabilised diode lasers at 633 nm was carried out between ISI (Institute of Scientific Instruments, Academy of Sciences of the Czech Republic) and MIKES in Espoo, Finland, September 2000. However, the ISI diode laser suffered some damages during the export to Finland. Therefore, no useful results were received during the comparison.

International (EA or other) intercomparisons for accredited calibration laboratories

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

A. Zarka, A. Abou-Zeid, D. Chagniot, J.-M. Chartier, J.-F. Cliché, O. Cip, C. Edwards, F. Imkenberg, P. Jedlicka, B. Kabel, A. Lassila, J. Lazar, Y. Millerioux, M. Merimaa, H. Simonsen, M. Tetu, and J.-P. Wallerand, International comparison of eight semiconductor lasers stabilized on 127I2 at λ=633 nm, *Metrologia* 37 (2000) 329-339.

A. Lassila, K. Riski, J. Hu, T. Ahola, S. Naicheng, L. Chengyang, P. Balling, J. Blabla, L. Abramova, Yu. G. Zakharenko, V. L. Fedorin, A. Chartier and J.-M. Chartier, International comparison of He-Ne lasers stabilized with $^{127}I_2$ at $\lambda \approx 633$ nm: Use of the FIFTH or the THIRD Harmonic-locking techniques compared, Accepted for publication in *Metrologia*.

H. Simonsen, J. Hu, and K. Nyholm "International comparison of He-Ne lasers stabilized with I_2 at $\lambda \approx 543$ nm (December 1999): Northern European lasers", *Metrologia*, (in press).

M. Merimaa, P. Kokkonen, K. Nyholm, and E. Ikonen, "A portable laser frequency standard at 633 nm with a compact external-cavity diode laser", *Metrologia* (submitted).

Conferences

M. Merimaa, P. Kokkonen, K. Nyholm, and E. Ikonen, "A compact iodine stabilized external-cavity diode laser at 633 nm with a novel transmission grating", *Conference on Precision Electromagnetic Measurements*, May 14–19, 2000, Sydney, Australia, Conference Digest, pp. 679–680.

K. Nyholm, T. Ahola, J. Hu, and E. Ikonen, "Stabilization and frequency measurements of green He-Ne lasers", Proceedings of the XXXIV Annual Conference of the Finnish Physical Society, March 9–11, 2000, Espoo, Finland, p. 69.

Reports

A. Lassila and S. Nevalainen, Nanometritason mittaukset – kartoitus, MIKES publication J5/2000, 37 p.

Intercomparison reports

Lectures

A. Lassila, Nanometrologia – lyhyt katsaus aiheeseen, Mittaus 2000, seminar, 9-10 May 2000, 15 p.

A. Lassila, Lyhyiden etäisyyksien mittaukset, Mittaukset konepajassa, seminar, 25-26 May 2000, 15 p.

Other activities

A. Lassila was a member and secretary of the Expert Group on length metrology, Advisory Commission for Metrology.

A. Lassila participated in the meeting of CCL - Working Group for Dimensional Metrology (WGDM), September 19-20, 2000.

K. Nyholm acted as a pre-examiner of Jussi Larjo's doctoral thesis, "Optical Diagnostics of Chemical Vapour Deposition", Tampere University of Technology, Publications 310, Tampere 2000.

A. Lassila participated in the Euspen 1st topical conference on Fabrication and Metrology in Nanotechnology at Copenhagen, May 28-30, 2000.

Guest researcher

Mrs Xu Jie, National Institute of Metrology, Beijing China, 1 January 2000 – 31 March 2000.

The following persons visited the laboratory

H. Karlsson, Justervesenet (JV), Norway, January 27-28, 2000.

Dr. L. Vitushkin, BIPM, October 5, 2000.

Dr. Xu Gan, (PSB), Singapore, September 12, 2000.

J. Lazar and O. Cip, Institute of Scientific Instruments, Czech Republic, September 25 – November 6, 2000.

The laboratory personnel made the following visits

A. Lassila, Danish Institute of Fundamental Metrology (DFM), May 26, 2000.

CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) MANUFACTURING TECHNOLOGY

QUANTITIES

Length	Angle	Flatness	Straightness
Roundness	Cylindricity	Surface roughness	

PERSONNEL OF THE LABORATORY

Heikki Lehto	Senior Research Scientist, Head of the Laboratory
Björn Hemming	Research Scientist
Janne Haltia	Research Scientist, until end of May
Raimo Mylläri	Research Assistant
Ilkka Palosuo	Research Trainee
Ilkka Raeluoto	Research Assistant
Asko Rantanen	Research Assistant, from beginning of December

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

Length: HP-Laser-Interferometers and frequency-stabilised lasers (red and green) are calibrated with Ion-stabilised laser. Gauge blocks are calibrated interferometrically with the red and green lasers.

Angle: Angle polygons are calibrated with two autocollimators. Autocollimators and the angle options of the Laser-interferometers are calibrated with tangential bar and length measuring instruments. Angle tables are calibrated with polygon and autocollimators using the error separation method.

Flatness: Optical flats are calibrated by comparing them to each other and rotating them 90° with natrium light. Surface plates are calibrated with HP Laser -interferometer (angle options) by measuring straightness in three directions.

Straightness: Straightness normal is calibrated like flats.

Roundness: Roundness normal (glass ball, flick standards and the oval standards) is calibrated with the roundness measuring machine (using the error separation method), length measuring instruments and form measuring instruments. The roundness measuring machine is calibrated with the roundness standards and using the laser-interferometer as scale for the sensor.

Cylindricity: Cylidricity unit is based to the roundness and straightness measurements. The standards are calibrated by using error separation method (straightness).

Surface roughness: The surface roughness-measuring machine is calibrated with gauge blocks, optical flats, laser-interferometer and PTB roughness standards.

Maintenance

All the standards and measuring machines are calibrated and maintained according to the documented routines.

Development

Calibration instructions
The aim of the MIKES/Industry project is to harmonise the measuring procedures, which are used for calibrations of different measuring devices. There are about 20 instruction sets in use in industry.

Dial indicators
The aim of this MIKES project was to develop MIKES´s capability for automated calibration instrumentation by using the image processing technique. The developed system has been reported and used for some calibrations. The accuracy of the calibration is better than the accuracy of the manual calibration and there is possible to take more readings so that you get much more information about the dial indicator. The use of the instrument is on other hand more complicated than the use of old manual systems.

Optical flats
The aim of this MIKES project is to develop or take in use calibration instrumentation for calibration of optical flats. A ZYGO flatness interferometer has been bought and taken into use. The calibration of the instrument has shown that the accuracy of the flatness measurement on 160 mm diameter is better than 30 nm.

2D-Optics
The aim of this MIKES project is to develop a measuring and calibration instrument for calibration of optical 2d-standards. The instrument has been designed and the x/y-table has been built. Most of the measuring instruments like the mirrors and the laser-interferometers have been bought.

Multibeam
The aim of this EU-project, where MIKES acts as co-ordinator, is to develop calibration instruments and methods for machine-tool calibration. The methods for machine-tool measurements have been improved and reported. They will later affect to the international ISO-standards. New prototype for 3-beam laser has been developed within this project developed. Programs for estimating the accuracy of the products or the needed accuracy of the machine tools have been developed. Near the end of the year 2000 an international conference has been held in Graz.

Temperature compensation in SIP
The aim of this MIKES-project is to improve the accuracy of length measurements in the SIP M550 length-measuring machine. There are Pt100 temperature sensors at the scale and body of the machine and two sensors, which can be used for work pieces. The accuracy of the internal measurements have been improved by chancing the sensor to a sensor where the repeatability is 0.01 µm.

Compensation of the air temperature in laser measurements
The aim of this MIKES- project is to improve the accuracy of laser measurement. It is important to know the air temperature exactly in the same air where the laser beam is. Data EMV Oy has developed instrumentation based on the speed of voice and the first results are very promising. It seems that an accuracy of 1 µm on 10 m can be possible.

Improvement of the calibration of laser interferometers
The aim of this MIKES-project is to improve the accuracy of calibration of laser interferometers. The calibration includes the calibration of material and environmental sensors. The instrumentation to calibrate the material temperature, air temperature and air pressure has been improved. The calibration is faster and more accurate.

Intercomparisons

International comparisons

EUROMET 471 Comparison of short gauge block by interferometry
The measurements have been done and reported 1999 by VTT. Unofficially we have got to know that there was nothing wrong in our results, but the results are not available.

EUROMET 533 High precision roundness
MIKES/VTT co-ordinates this intercomparison where all measurement have been done and the draft report has been distributed. The biggest E_n value for the co-ordinator is 0.30.
EUROMET 570 Comparison of squareness measurements
The standards will come to MIKES for measurements in April 2001.

EUROMET 600 Comparison of surface texture measurements
The standards will come to MIKES for measurements in 2001.

EUROMET 601 Mechanical measurement of long gauge blocks
The standards will come to MIKES for measurements in June 2001.

International (EA or other) intercomparisons for accredited calibration laboratories

EA M20 Conventional measuring instruments micrometer and dial indicator
MIKES/VTT co-ordinates this comparison where all measurement have been done and all participants have got feed-back from their results. The final report has been sent to EA in April 2000.

EA M21 Comparison of step gauge measurements
One Finnish laboratory has participated this comparison and made the measurements. The results compared to the preliminary reference values are good. There is no final or draft report from the comparison.

EA M22 Calibration of Taper Standards
One Finnish laboratory has participated this comparison and made the measurements. The results compared to the preliminary reference values are good. There is no final or draft report from the comparison.

NIF M3 Calibration of one axial testing machines, Extensiometer, Force measurement
MIKES/VTT/RAUTE co-ordinates this comparison where all measurement have been done and all participants have got feed-back from their results. The final report has been sent to NIF in January 2000.

National intercomparisons for accredited calibration laboratories

D5 Comparison of ring gauge measurements
MIKES/VTT co-ordinates this comparison where all measurement have been done and all participants have got feed-back from their results. There is no report about the comparison.

Bilateral comparisons
MIKES has organised bilateral comparisons in accredited laboratories K022; K023; K027 and K039. The comparisons have been reported in the reports given to FINAS.

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

Conferences

Mittaukset konepajassa, 25-26 May 2000, Hotel Majvik, Kirkkonummi.

Higher precision of machine tools - The European approach, 13th – 14th November, Graz, Austria.

Reports

Heikki Lehto, Mikrotecnik kuulumisia, Mittaukset konepajassa, Kirkkonummi, 25 May 2000, 3 p.

Björn Hemming, Mittakellojen kalibrointi konenäöllä, Mittaukset konepajassa, Kirkkonummi, 25 May 2000, 12 p.

Heikki Lehto, Mittausten ja kalibrointien “sudenkuopat”, Mittaukset konepajassa, Kirkkonummi, 25 May 2000, 10 p.
Heikki Lehto, Introduction of the Multibeam Project, Higher precision of machine tools - The European approach, 13th – 14th November, Graz, Austria, 6 p.

Heikki Lehto, Summary of the Multibeam Project, Higher precision of machine tools - The European approach, 13th – 14th November, Graz, Austria, 3 p.

Leonid Mihailjov, Antti Lassila, Heikki Lehto, The phenomena of straight relationship between wavelength of light and speed of sound is discovered, Higher precision of machine tools - The European approach, 13th – 14th November, Graz, Austria, 6 p.

Heikki Lehto, Jäljitettävyys ja mittausepävarmuuden määrittäminen fysikaalisille suureille, Kalibroinnit ja laatujärjestelmät, Espoo 28th November 2000, 7 p.

Intercomparison reports

EUROMET 533 High precision roundness, Draft Report, Björn Hemming, 14th July 2000.

EA M20 Conventional measuring instruments micrometer and dial indicator, Final Report, Björn Hemming, Heikki Lehto, April 2000.

NIF M3 Calibration of one axial testing machines, Extensiometer, Force measurement, Final Report, Heikki Lehto, Aimo Pusa, January 2000.

Lectures

Heikki Lehto, Mittausvirheet ja mittausepävarmuus, TAKK, 8 March 2000, Tampere, 25 p.

Heikki Lehto, Kalibrointi, TAKK, 8 March 2000, Tampere, 12 p.

Heikki Lehto, Mittausvirheet ja mittausepävarmuus, EKAKK, 22 November 2000, Lappeenranta, 25 p.

Heikki Lehto, Kalibrointi, EKAKK, 22 November 2000, Lappeenranta, 12 p.

Heikki Lehto, Kalibroinnit tasolla, AEL Mittausvälineiden huolto, tarkastus ja kalibrointi, 29th November 2000, Helsinki, 5 p.

Heikki Lehto, Kalibroinnit ilman kalibrointilaitteita, AEL Mittausvälineiden huolto, tarkastus ja kalibrointi, 29th November 2000, Helsinki, 7 p.

Heikki Lehto, Kalibrointilaitteiden kalibrointi, AEL Mittausvälineiden huolto, tarkastus ja kalibrointi, 29th November 2000, Helsinki, 7 p.

Other activities

EUROMET: The meeting of Expert Group ”Dimensional Metrology” in OSLO, 9th–10th October 2000.

EA: The meeting of Expert Group ”Dimensional Metrology” in Braunschweig, 6th–7th November 2000.

Other Groups for co-operation: IMEKO, SLY, SFS, AEL, EKAKK.

Visitors from industry and metrology laboratories from Finland and different foreign countries.

CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) ELECTRICITY, TIME AND ACOUSTICS

QUANTITIES

DC voltage	DC current	Resistance	AC voltage
AC current	Electric power	Electric energy	Capacitance

PERSONNEL

Panu Helistö	Senior Research Scientist, Team Leader
Pekka Immonen	Research Scientist
Mikael Laitinen	Research Engineer
Tapio Mansten	Senior Research Scientist
Kari Ojasalo	Research Scientist
Risto Rajala	Research Engineer
Aleksandre Satrapinski	Research Scientist
(Anssi Rautiainen,	Research Engineer, VTT Automation)

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

DC voltage: Josephson voltage standard, Weston and Zener standards, resistive voltage divider. **Resistance:** resistance standards and quantum-Hall standard. **AC voltage:** multi-junction and Fluke 540B thermal AC/DC converters. **AC current:** multi-junction and Fluke 540B thermal AC/DC converter and A40 shunt resistors. **Power:** HEG power comparator, digital sampling wattmeter. **Capacitance:** Andeen-Hagerling and GenRad capacitance standards.

Maintenance

DC voltage: New automatic Zener comparison and calibration system was taken into use in 2000.
Resistance: Accurate measurements of the temperature coefficients (TC) of secondary resistance standards, 100 Ohm and 10 kOhm, (Guildline), were performed by CCC bridge against the 100 Ohm primary standard. The defined values of TC allow to increase the accuracy of the calibration of working and customer standards. The Pt500 temperature sensors and PC program were prepared for automatic resistance calibration.
Capacitance: Continuous comparison of reference standards was started in Autumn (6 measurements/day). New measurement cables and a new 1 µF capacitance standard were obtained.
AC voltage: Voltage stepup was continued and finalised to 100 V level. There are still some difficulties with 300 V and 1000 V levels. New ac voltmeter was obtained.
AC current: Some maintenance measurements were made.
General: All ambient surveillance computers and all measurement computers were changed to work in UTC time instead of the Finnish local time.

Development

DC voltage
The long term noise of Zener standards was studied with measurements and by using spectral analysis and Allan variance techniques. The noise turned out to be dominated by 1/f contribution in all practical measurements. (CPEM'2000).

Resistance

New 100-Ohm transfer resistance standard was build. The thermoenclosure for a new transfer resistance standard was designed and fabricated. That enclosure permanently maintains the temperature and the pressure and monitors and saves these parameters (and also acceleration) during transportation. Use of a conventional CCC resistance bridge for the measurements of low-value resistors was studied. The parameters for the measurements by CCC bridge were defined and the 0.01 Ohm standard resistor (Cambridge type) was measured.

AC current stepup
A new shunt resistance construction was designed and two new shunts were built (1 A, 5 A).

AC traceability
A new ac DVM (Fluke 5790) was purchased.

50 Hz power and current
Extension of the range of the power and current measurements. Determination of the uncertainty budget of the sampling wattmeter. Analysis of the uncertainties of the dc sampling mode of HP 3458A multimeter. (CPEM'2000).

High frequency
Purchasing instrumentation for high frequency electricity metrology was started in 2000.

Laboratory database
The development of a comprehensive laboratory database for automatic maintenance and calibration was started.

Intercomparisons

International comparisons

CCEM-K9: The measurements (500 V and 1000 V ac voltage) were made in May 2000. The report has not been done and badly late due to problems in higher (300 V and 1000 V) ranges. This is a key comparison that we have already failed once in 1996.

EUROMET #464: The measurements (low AC voltages) were made in September 2000. The report is under preparation.

Euromet 473: Comparison of the measurement of current transformers, 1 - 1000 A / 5 A. Measurements of MIKES in May 2000 were reported to NPL in the Autumn. Final report has not been published yet.

Euromet 449: Intercomparison of DC voltage ratios up to 1000 V. Results of MIKES were reported in February 2000. Final report has not been published yet.

Euromet 358. AC Power measurement at 50 Hz. MIKES results were reported in March 2000. Final report has not been published yet.

International (EA or other) intercomparisons for accredited calibration laboratories

EA EL-27: The comparison device (a DMM, several quantities and ranges) was in Finland from 19 Oct. to 30 Nov. and visited five accredited laboratories during that time. It was measured at MIKES both when it came to Finland and when it left Finland. The report is expected to be finished during January 2001.

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

Hassel, Juha; Seppä, Heikki; Kiviranta, Mikko. A new way to realize a programmable Josephson voltage standards, 22nd Conference on Low Temperature Physics. Espoo, 4 – 11 August 1999. Physica B 284-288, 2000 (2000), 2073 – 2074.

Hassel, J., Seppä, H., Grönberg, L., Suni, I., and Helistö, P. Progress in Josephson voltage standard development. CPEM Digest (Conference on Precision Electromagnetic Measurements), 14-19 May 2000, Sydney, Australia, 399-400.

Helistö, P., Seppä, H., and Rautiainen, A. Measurement uncertainty in the 1/f noise region: Zener voltage standards. CPEM Digest (Conference on Precision Electromagnetic Measurements), 14-19 May 2000, Sydney, Australia, 401-402.

Helistö, P., Rautiainen, A., and Seppä, H. Automatic high precision audio frequency power standard. CPEM Digest (Conference on Precision Electromagnetic Measurements), 14-19 May 2000, Sydney, Australia, 41-42.

Helistö, P. and Seppä, H. 2001. Measurement uncertainty in the presence of low frequency noise. *IEEE Trans. Instr. Meas.* Submitted.

A. Satrapinski, H. Seppä, B. Schumacher, P. Warnecke, F. Delahaye, W. Poirier, and F. Piquemal, "Quick Comparison of QHR System Using a 100 Ohm Transfer Resistor", Conference Digest, CPEM2000, 14-19 May 2000, Sydney, Australia, pp. 560-561.

A. Satrapinski, and H. Seppä, "100 Ohm Transfer Standard", Conference Digest, CPEM2000, 14-19 May 2000, Sydney, Australia, pp. 102-103.

A. Satrapinski, H. Seppä, B. Schumacher, P. Warnecke, F. Delahaye, W. Poirier, and F. Piquemal, "Comparison of Four QHR System Within One Month Using A Temperature and Pressure Stabilized 100 Ohm Resistor", submitted to IEEE Trans. Instr. Meas.

Kyynäräinen, Jukka; Oja, Aarne; Seppä, Heikki. A micromechanical rms-to-dc converter, CPEM Digest (Conference on Precision Electromagnetic Measurements), 14-19 May 2000, Sydney, Australia, 699-700.

Oja, Aarne; Kyynäräinen, Jukka; Seppä, Heikki; Lampola, T. A micromechanical dc-voltage reference, CPEM Digest (Conference on Precision Electromagnetic Measurements), 14-19 May 2000, Sydney, Australia, 701-702.

Conferences

Helistö, P., Seppä, H., and Rautiainen, A.: Measurement uncertainty in the 1/f noise region: Zener voltage standards. Conference on Precision Electromagnetic Measurements, 14-19 May 2000, Sydney, Australia (poster).

Helistö, P., Rautiainen, A., and Seppä, H.: Automatic high precision audio frequency power standard. Conference on Precision Electromagnetic Measurements, 14-19 May 2000, Sydney, Australia (poster).

A. Satrapinski, H. Seppä, B. Schumacher, P. Warnecke, F. Delahaye, W. Poirier, and F. Piquemal, "Quick Comparison of QHR System Using a 100 Ohm Transfer Resistor", Conference CPEM2000 14-19 May 2000, Sydney, Australia, (poster).

A. Satrapinski, and H. Seppä, "100 Ohm Transfer Standard", Conference, CPEM2000 14-19 May 2000, Sydney, Australia, (poster).

Oja, Aarne: Microelectromechanical references for electrical metrology Symposium on Microtechnology in Metrology and Metrology in Microsystems. Delft, 31 August - 1 September 2000 (talk).

Reports

Kyynäräinen, Jukka; Oja, Aarne; Seppä, Heikki: Microelectromechanical references for electrical metrology.

Proceedings/Symposium on Microtechnology in Metrology and Metrology in Microsystems. Delft, 31 August - 1 September 2000. Delft University of Technology. Delft (2000), 31 - 39.

Intercomparison reports

Lectures

Measurement 2000 ("Mittaus 2000") at Hotel Haaga, 10 May 2000. Lectures by Kalevi Kalliomäki and Tapio Mansten, "Electrical Metrology, a General View", "The Traceability of AC Current and AC Voltage in Finland".

Fluke seminar on metrology 8 June 2000 at Hotelli Haaga Helsinki. Risto Rajala gave a speech on uncertainty calculations of calibrations of DC-voltage standards and Mikael Laitinen on automation of oscilloscope calibrations.

A. Satrapinski, Lecture in ETL (Japan) on 3 October 2000, “Realization of the unit of resistance in Finland and cryogenic instruments”

Other activities

P. Helistö:
Euromet high frequency expert group meeting, Brussels, 22-23 March 2000.
VSL/Delft, 24 March 2000.
PTB/Braunschweig, 27-28 March 2000.
NPL, 29, 31 March 2000.
Agilent Winnersh service centre, 30 March 2000.
Ac/dc working group meeting, Sydney, 14 May 2000.
Symposium on Microtechnology in Metrology and Metrology in Microsystems. Delft, 31 August - 1 September 2000.
Fluke Precision Measurement, Norwich, UK 26-27 September 2000.
Euromet Electricity Contact Persons meeting, NPL, Teddington 8-9 November 2000.
Member of MNK-S.
Euromet Electricity Contact Person.

P. Immonen:
MNK-S member.

T. Mansten:
EA meeting in 6-8. Nov. 2000 at NPL.
MNK-S member.

A. Satrapinski:
AC QHR working group meeting on 18 May 2000 in Sydney, Australia.
ETL, Japan, October 2000.

E. Frantsuz, V.Khavinson. Seminar "Realization of kg, based on the superconducting levitation body", 5 April 2000.
L. Rainbird, L. Andersson, Fluke Europe, 9 June 2000.
D. Deaver/Fluke USA, L Andersson/Fluke Europe, 14 November 2000.
T. Anbinderis, Elmika, Vilnius, 15 November 2000.
P. Roberts, M. Ashcroft/Fluke Precision Measurement UK, 24 November 2000.

CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) ELECTRICITY, TIME AND ACOUSTICS

QUANTITIES

Time	Time interval	Frequency

PERSONNEL

Kalevi Kalliomäki	Senior Research Scientist, Head of the Laboratory
Tapio Mansten	Senior Research Scientist
(Anssi Rautiainen	Research Engineer, VTT Automation)

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

Time: Two Cs-clocks, 4 GPS receivers, 2 Loran-C clocks (NELS&RNS).
Frequency: Two Cs-clocks, two rubidium oscillators, several OCXO:s.

Maintenance

A used HP5071A Cs clock was bought from Lappeenranta University of Technology.

Development

NTP
Two TymServe 2100 NTP servers and a IRIG B GPS-source (StarTime) were bought.

NTTS
A NTTS National Trusted Time Server device was acquired from Datum for pilot testing. The project is part of the FINNISH CITIZEN CARD AND ELECTRONIC IDENTIFICATION project, co-ordinated by The Finnish Population Register Centre. Other partners are Sonera SmartTrust, ICL, Certall, Elisa Communications, Osuuspankkiryhmä, Leonia etc.

Intercomparisons

International comparisons

International (EA or other) intercomparisons for accredited calibration laboratories

EA-FR1: The pilot laboratory has produced a draft report for frequency comparison EA-FR1. Due to the difficulties in the result interpretation, a national expert from each country is to be named. An expert meeting is convened in May 2001 to decide on the final report.

National intercomparisons for accredited calibration laboratories

One frequency comparison which was reported in the assessment document.

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

Conferences

K. Kalliomäki and T. Mansten attended the EFTF 14 Conference in Turin, Italy, in March 2000, where they presented the papers below.

A poster (below) was presented at URSI XXV National Convention on Radio Science at Säätytalo and Tieteiden talo, Helsinki, Finland, September 21-22, 2000 by Jari Mannermaa (Nokia).

Reports

J. Mannermaa, K. Kalliomäki, T. Mansten, S. Turunen, "Short-term Stability of Crystal Oscillators in Commercial GPS Receivers", Proceedings of 2000 EFTF Meeting, Turin, Italy (to be published).

K. Kalliomäki, T. Kiibus, T. Mansten, R. Rebane, "Frequency Interlaboratory Comparison Between Estonia and Finland", Proceedings of 2000 EFTF Meeting, Turin, Italy (to be published).

J. Mannermaa, K. Kalliomäki, T. Mansten, S. Turunen, "Detection of Tracking Loops Performance of GPS Receivers from PPS Measurements", URSI XXV National Convention on Radio Science, proceedings.

K. Kalliomäki and T. Mansten: article about the Discontinuing of GPS Selective Availability in Spring 2000 (in Finnish), Helsingin Sanomat 29 July 2000.

Intercomparison reports

Lectures

Other activities

See above, T&F EUROMET Meeting in Turin, March 2000. Before EFTF 14 conference.
M. Hastings, P. DiToro, Datum, 23 August 2000.
J. Jämiä/ICL Data, Petri Puhakainen/Certall, 8 September 2000.

CENTRE FOR METROLOGY AND ACCREDITATION (MIKES) ELECTRICITY, TIME AND ACOUSTICS

QUANTITIES

Sound pressure

PERSONNEL

Panu Helistö	Senior Research Scientist
Kari Ojasalo	Research Scientist

REALISATION AND MAINTENANCE

The unit of sound pressure is realised by the closed coupler reciprocity technique using half inch and one inch standard condenser microphones.

The calibration system was transferred from Tele Engineering Finland to MIKES in spring 2000. Before taking it in use in MIKES, some changes were made to the system. A switch mode power supply was constructed. This supply generates the power needed by preamplifiers and signal conditioning circuitry. This supply generates also the 200 volt polarization voltage for the microphones. Sensitivity to common-mode signals was reduced with symmetrical input isolation amplifier.

Activities of the Acoustics laboratory will start effectively during the year 2001.

3.6 HELSINKI UNIVERSITY OF TECHNOLOGY (HUT) METROLOGY RESEARCH INSTITUTE

QUANTITIES

Luminous intensity	Spectral irradiance	Colour temperature	Reflectance
Illuminance	Spectral radiance	Optical power	Spectral responsivity
Luminance	Colour coordinates	Transmittance	Optical wavelength

PERSONNEL

Erkki Ikonen	Professor, Head of the National Standards Laboratory
Hanne Ludvigsen	Research Fellow
Jaana Hänninen	Administrative Secretary
Seppo Metsälä	Laboratory Technician
Jouni Envall	Research Assistant
Jari Hovila	Research Assistant
Toomas Kübarsepp	Research Scientist (till November 30)
Petri Kärhä	Senior Research Scientist, Quality Manager
Kristian Lahti	Project Manager
Farshid Manoocheri	Research Scientist, Head of Calibration Services
Saulius Nevas	Research Scientist
Tapio Niemi	Research Scientist, Student Advisor
Mart Noorma	Research Assistant
Pasi Toivanen	Research Scientist
Eero Vahala	Research Assistant

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

The primary standard of optical power measurements is a cryogenic absolute radiometer operated with laser sources. Trap detectors and a pyroelectric radiometer are used as transfer standards to other wavelengths and power levels. Units of luminous intensity and illuminance are realised with a reference photometer constructed from a trap detector, a $V(\lambda)$-filter and a precision aperture. Unit of luminance is realised by measuring the luminous intensity of an integrating sphere source with known output area. Unit of spectral irradiance is realised with an absolutely characterised filter radiometer, with inter-changeable band-pass filters. Values between the discrete wavelengths are interpolated using physical models. Spectral radiance, colour co-ordinates and correlated colour temperature are derived from spectral irradiance measurements. Regular spectral transmittance of filters, regular spectral reflectance of optical components, and spectral responsivity of detectors are calibrated using a reference spectrometer. Measurements of regular spectral reflectance are made by using a dedicated apparatus in the reference spectrometer. Spectral responsivity measurements are made with a trap detector as a reference. Optical wavelength is measured with a Fourier transform wavemeter, traceable to the iodine stabilised laser of the Centre for Metrology and Accreditation.

Maintenance

The realisations of the quantities mentioned above were maintained. In addition, setups for measuring linearity and spatial uniformity of detectors, and areas of apertures, were maintained. Preparations for the mutual recognition arrangement within EUROMET and CCPR have required an exceptionally high amount of work, which has also been financed by the maintenance budget.

Development

Realisation of the luminous flux unit using an absolute integrating sphere method
The project has been completed. HUT now has a calibration service for luminous flux with an uncertainty of 1 %. The uncertainty has been verified in a bilateral comparison with NIST. The two scales agree within 0,06 %.

Calibration facility for spectral diffuse reflectance
The setup for relative diffuse reflectance measurements has been finished. HUT now has capability for measuring diffuse reflectance with an uncertainty of 0,4 % in the wavelength region from 360 to 830 nm. The traceability is to NRC and PTB. It is planned that the project would continue towards building an absolute scale starting in 2001.

Calibration facility for fibre optic power meters
Part of the detectors have been built and characterised. HUT now has capabilities to measure fibre optic power with an uncertainty of 5 % at 1310 and 1550 nm wavelengths.

A new technique for the measurement of irradiance responsivity of filter radiometers
A frequency tuneable Ti:S laser has been taken into use for filter radiometer characterisations. The first test characterisations on an 800-nm filter radiometer have been performed during 2000.

Intercomparisons

International comparisons

CCPR-K1.a International comparison of spectral irradiance
The comparison is on spectral irradiance measurements of tungsten lamps in the wavelength region from 250 nm to 2500 nm. HUT participates in the wavelength region 290 – 900 nm. The measurements for this comparison were carried out by HUT in 2000.

CCPR-K2.b International comparison of spectral responsivity in the visible region
The comparison is on spectral responsivity measurements of trap detectors and photodiodes in the wavelength region from 300 nm to 1000 nm. The measurements for this comparison were carried out by HUT in 2000.

CCPR-K6 International comparison of regular spectral transmittance
The measurements for this comparison were carried out by HUT in 2000.

CCPR-S2 International comparison of aperture area measurements
The measurements for this comparison were carried out by HUT in 2000.

Bilateral comparison of spectral irradiance with NIST, USA
The spectral irradiance scales of NIST and HUT were compared in the 290 – 900 nm region. The comparison indicates an agreement except in the UVB region, where the discrepancies are slightly higher than the uncertainty of the comparison.

Bilateral comparison of illuminance with NIST, USA
The illuminance scales of NIST and HUT were compared. The comparison indicates an excellent agreement within the uncertainty of the comparison.

Bilateral comparison of luminous flux with NIST, USA
The new luminous flux scale of HUT was compared with the scale of NIST. The comparison indicates an excellent agreement within the uncertainty of the comparison.

Bilateral comparison of spectral responsivity with IFA-CSIC, Spain
The spectral responsivity scales of IFA-CSIC and HUT were compared in the wavelength region from 260 nm to 400 nm. The comparison indicates an agreement within the uncertainty of the comparison.

Bilateral comparison of optical frequencies of diode lasers with ISI Brno, Czech
Optical frequencies of diode lasers were compared at the HUT in 2000. Due to instability of one of the lasers, the results were inconclusive.

Improving the accuracy of ultraviolet radiation measurement
In this project funded by the SMT-programme of the EU, novel filter radiometer techniques developed by HUT are used to compare various ultraviolet calibration facilities in France (BNM), Finland and UK (NPL). HUT acts as

the pilot laboratory in the comparison and measured during 2000 all filter radiometers twice, before and after the measurements by other participants. According to the preliminary results, measurements of HUT are in agreement with NPL and BNM.

International comparison of fibre Bragg grating group delay (COST-project)
A comparison was carried out for measurements of group delay, bandwidth and relative transmittance for a fibre Bragg grating with several European participants. The results are not yet available.

International (EA or other) intercomparisons for accredited calibration laboratories

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

P. Kärhä, T. Kübarsepp, F. Manoocheri, P. Toivanen, E. Ikonen, R. Visuri, L. Ylianttila and K. Jokela, "Portable detector-based primary scale of spectral irradiance", *Journal of Geophysical Research* 105 (2000), pp. 4803-4807.

K. Jokela, L. Ylianttila, R. Visuri, P. Kärhä and E. Ikonen, "Intercomparison of lamp and detector based UV-irradiance scales for solar UV radiometry", *Journal of Geophysical Research* 105 (2000), pp. 4821-4827.

T. Kübarsepp, P. Kärhä and E. Ikonen, "Interpolation of the spectral responsivity of silicon photodetectors in the near ultraviolet", *Applied Optics* 39 (2000), pp. 9-15.

M. Merimaa, P. Kokkonen, K. Nyholm and E. Ikonen, "A portable laser frequency standard at 633 nm with a compact external-cavity diode laser" (submitted).

M. Merimaa, H. Talvitie, P. Laakkonen, M. Kuittinen, I. Tittonen and E. Ikonen, "Compact external-cavity diode laser with a novel transmission geometry", *Optics Communications* 174 (2000), pp.175-180.

M. Merimaa, H. Talvitie, I. Tittonen, P. Laakkonen, M. Kuittinen and E. Ikonen, "Compact external-cavity diode laser at 633 nm with a transmission grating", *Trends in Optics and Photonics Series (TOPS), reprinted from proceedings of Topical Meeting on Advanced Semiconductor Lasers and Their Applications '99* 31 (2000), pp. 56-57.

A. Zarka, A. Abou-Zeid, D. Chagniot, J.-M. Chartier, J.-F. Cliché, O. Cip, C. Edwards, F. Imkenberg, P. Jedlicka, B. Kabel, A. Lassila, J. Lazar, Y. Millerioux, M. Merimaa, H. Simonsen, M. Tetu, and J.-P. Wallerand, "International comparison of eight semiconductor lasers stabilized on $^{127}I_2$ at 633nm", *Metrologia* 37 (2000), pp. 329-339.

P. Toivanen, P. Kärhä, F. Manoochehri and E. Ikonen, "Realization of the unit of luminous intensity at HUT", *Metrologia* 37 (2000), pp. 131-140.

P. Toivanen, J. Hovila, P. Kärhä and E. Ikonen, "Realization of the units of luminance and spectral radiance at HUT", *Metrologia* (in press).

K. Lahti, J. Hovila, P. Toivanen, E. Vahala, I. Tittonen and E. Ikonen, "Realisation of the Luminous Flux Unit Using a LED Scanner for the Absolute Integrating Sphere Method", *Metrologia* (in press).

K. D. Stock, K.-H. Raatz, P. Sperfeld, J. Metzdorf, T. Kübarsepp, P. Kärhä, E. Ikonen and L. Liedquist, "Detector-stabilized FEL lamps as transfer standards in an international comparison of spectral irradiance", *Metrologia* (accepted).

Conferences

International conference proceedings

T. Niemi, M. Uusimaa, H. Ludvigsen, S. Tammela, P. Heimala, T. Kajava and M. Kaivola, "Simultaneous spectral filtering and wavelength monitoring of a DWDM transmitter using a tunable Fabry-Perot filter", *Optical Fiber Communication Conference, Osa Technical Digest*, Baltimore, Maryland, USA, March 5-10, 2000, pp. 28-30.

M. Merimaa, P. Kokkonen, K. Nyholm and E. Ikonen, "A compact iodine stabilized external-cavity diode laser at 633 nm with a novel transmission grating", *in Conference Digest*, *Conference on Precision Electromagnetic Measurements CPEM'00*, Sydney, Australia, May 14-19, 2000, pp. 679-680.

M. Merimaa, H. Talvitie, I. Tittonen, P. Laakkonen, M. Kuittinen and E. Ikonen, "Compact external-cavity diode laser at 633 nm with a transmission grating", *in proceedings of Northern Optics 2000*, Uppsala, Sweden, June 6-8, 2000, p. 50.

T. Kübarsepp, "Physical basis for interpolation of the spectral responsivity of Schottky barrier-based PtSi-nSi photodiodes", *EU-project working group meeting*, Berlin, Germany, May 13 - 17, 2000.

M. Merimaa, H. Talvitie, P. Laakkonen, M. Kuittinen, I. Tittonen and E. Ikonen, "Compact external-cavity diode laser at 633 nm with a transmission grating", *in Proceedings of the Northern Optics 2000*, Uppsala, Sweden, June 6-8, 2000, p. 50.

J. Hovila, K. Lahti, P. Toivanen, E. Vahala, I. Tittonen and E. Ikonen, "Absolute measurement of luminous flux", *in Proceedings of the Northern Optics 2000*, Uppsala, Sweden, June 6-8, 2000, p. 116.

T. Kübarsepp, P. Kärhä, F. Manoocheri, S. Nevas, P. Toivanen and E. Ikonen, "Compact facility for High-accuracy measurements of spectral irradiance in the UV-VIS-NIR region", *in Proceedings of the Northern Optics 2000*, Uppsala, Sweden, June 6-8, 2000, p. 141.

K. Lahti, M. Heiliö, E. Vahala, A. Kasvi and I. Tittonen, "Laser frequency stabilization using a phase modulation scheme", *in Proceedings of the Northern Optics 2000*, Uppsala, Sweden, June 6-8, 2000, p. 143.

K. Lahti, E. Vahala and I. Tittonen, "Matrix based method for determination of gaussian beam parameters", *in Proceedings of the Northern Optics 2000*, Uppsala, Sweden, June 6-8, 2000, p. 144.

S. Nevas, F. Manoocheri and E. Ikonen, "Measurement of spectral diffuse reflectance based on an integrating sphere and a high-accuracy spectrometer", *in Proceedings of the Northern Optics 2000*, Uppsala, Sweden, June 6-8, 2000, p. 162.

T. Niemi, M. Uusimaa, G. Genty and H. Ludvigsen, "Characterization of dense group delay ripple using phase shift method: effect of modulation frequency", *in Proceedings of the Northern Optics 2000*, Uppsala, Sweden, June 6-8, 2000, p. 163.

M. Uusimaa, T. Niemi, S. Tammela and H. Ludvigsen, "A tunable micro-filter for simultaneous wavelength monitoring and spectral filtering of a DWDM transmitter", *in Proceedings of the Northern Optics 2000*, Uppsala, Sweden, June 6-8, 2000, p. 199.

T. Niemi, T. Laukkanen, S. Tammela and H. Ludvigsen, "Wavelength monitoring of multi-channel DWDM-systems using a single temperature-tunable Fabry-Perot filter" *in Proceedings of Conference on Lasers and Electro-Optics Europe*, September 10-15, 2000, p. 16.45.

T. Niemi, M. Uusimaa and H. Ludvigsen, "Measurements of dense group delay ripple using the phase shift method: Effect of modulation frequency" *in Technical Digest of Symposium of Optical Fiber Measurements 2000*, Boulder, Colorado, USA, September 26 - 29, 2000, pp. 165-167.

National conference proceedings

K. Lahti, E. Vahala, M. Heiliö, A. Kasvi and I. Tittonen, "Digital laser frequency stabilisation using a High-Q optical resonator as a reference", *in Proceedings of the XXXIV Annual Conference of the Finnish Physical Society*, Report TKK-F-A797, Espoo 2000, paper 2.4.

K. Nyholm, T. Ahola, J. Hu and E. Ikonen, "Stabilization and frequency measurements of green He-Ne lasers", *in Proceedings of the XXXIV Annual Conference of the Finnish Physical Society*, Report TKK-F-A797, Espoo 2000, paper 2.14.

Reports

I. Tittonen (editor), *Annual report 1999*, Metrology Research Institute, Helsinki University of Technology, Espoo 2000, Metrology Research Institute Report 16/2000, 65 p.

P. Kärhä (editor in chief), *UVNews*, The official newsletter of the Thematic Network for Ultraviolet Measurements, Issue 4 , Espoo 2000, 44 p.

P. Toivanen, *Detector based realisation of units of photometric and radiometric quantities*, Metrology Research Institute, Helsinki University of Technology, Espoo 2000, Metrology Research Institute Report 17/2000, 100 p.

A. Pietiläinen and M. Merimaa, *Mittaustekniikan perusteiden laboratoriotyöt*, 7th edition, Espoo 2000, 108 p. (in Finnish).

P. Kärhä (editor in chief), *UVNews*, The official newsletter of the Thematic Network for Ultraviolet Measurements, Issue 5, Espoo 2000, 28 p.

P. Kärhä (editor in chief), *UVNews*, The official newsletter of the Thematic Network for Ultraviolet Measurements, Issue 6, Espoo 2000, 148 p.

T. Niemi, M. Söderlund and K. Ylä-Jarkko, "Uusien optisten WDM-verkkojen mittaukset", *Prosessori*, 2/2000, pp. 53-56. (in Finnish).

Intercomparison reports

A. Zarka, A. Abou-Zeid, D. Chagniot, J.-M. Chartier, J.-F. Cliché, O. Cip, C. Edwards, F. Imkenberg, P. Jedlicka, B. Kabel, A. Lassila, J. Lazar, Y. Millerioux, M. Merimaa, H. Simonsen, M. Tetu, and J.-P. Wallerand, "International comparison of eight semiconductor lasers stabilized on $^{127}I_2$ at λ = 633 nm", *Metrologia* 37 (2000), pp.329-339.

Lectures

Other activities

Conferences and meetings

Euromet Consultative Committee/Rapporteur Meeting, Bern, Switzerland, January 12-13, 2000; Erkki Ikonen.

Optical Fiber Communication Conference (OFC2000), Baltimore, Maryland, USA, March 5-10, 2000; Tapio Niemi.

XXXIIII Annual Conference of the Finnish Physical Society, Espoo, Finland, March 9-11, 2000; Miika Heiliö, Erkki Ikonen, Aki Kasvi, Petri Kärhä, Kristian Lahti, Thomas Linvall, Ilkka Tittonen, Maria Uusimaa, Eero Vahala and Pekka Wallin.

Third International Conference on Modeling and Simulation of Microsystems, San Diego, USA, March 27-29, 2000; Tuomas Lamminmäki and Kaius Ruokonen.

POLAR kick off meeting, Tampere, Finland, March 30, 2000; Hanne Ludvigsen.

EUROMET Contact Persons Meeting, Istanbul, Turkey, April 1-5, 2000; Erkki Ikonen and Petri Kärhä.

Optics Expert Seminar, Helsinki, Finland, April 28, 2000; Hanne Ludvigsen.

The Second Training Course on Ultraviolet Measurement, Innsbruck, Austria, May 4-5, 2000; Saulius Nevas.

COST 265 - 3rd MC meeting, Gothenburg, Sweden, May 8-10, 2000; Hanne Ludvigsen.

FOToN - 2nd MC meeting, Gothenburg, Sweden, May 9, 2000; Hanne Ludvigsen.

EU-project working group meeting, Berlin, Germany, May 13 - 17, 2000; Toomas Kübarsepp and Petri Kärhä.

Conference on Precision Electromagnetic Measurements CPEM'00, Sydney, Australia, May 14 - 19, 2000; Mikko Merimaa and Goëry Genty.

CCPR KC WG/RMO Meeting, London, United Kingdom, June 4 - 6, 2000; Erkki Ikonen.

Northern Optics 2000, Uppsala, Sweden, June 6 - 8, 2000, Ilkka Tittonen, Miika Heiliö, Jari Hovila, Aki Kasvi, Ossi Kimmelma, Kristian Lahti, Mikko Merimaa, Saulius Nevas, Tapio Niemi, Eero Vahala and Maria Uusimaa.

EUROMET Committee Meeting, Istanbul, Turkey, June 13 - 16, 2000; Erkki Ikonen.

Tag der Physik meeting and Zehn Jahre Quantenoptik in Konstanz meeting, July 6 -12, 2000; Ilkka Tittonen.

EU-project working group meeting, Borås, Sweden, September 5, 2000; Toomas Kübarsepp and Petri Kärhä.

3rd international workshop on detector-based UV radiometry (EUROMET project 437), Borås, Sweden, September 6, 2000; Erkki Ikonen, Toomas Kübarsepp and Petri Kärhä.

Fourth Workshop of the Thematic Network for UV Measurements, Borås, Sweden, September 6 - 8, 2000; Erkki Ikonen, Toomas Kübarsepp and Petri Kärhä.

2000 Conference on Lasers and Electro-optics Europe, CLEO, Nice, France, September 10-15, 2000; Tapio Niemi, Thomas Lindvall and Ilkka Tittonen.

Symposium of Fiber Optic Measurements 2000, Boulder, Colorado, USA, Sept 26 - 29, 2000; Tapio Niemi.

Second Annual Seminar on Finnish Silicon Sampo, Helsinki, Finland, October 2 - 3, 2000; Kaisa Nera and Ilkka Tittonen.

3rd Regional FOToN Meeting, Vantaa, Finland, October 4, 2000; Goëry Genty, Erkki Ikonen, Petri Kärhä and Hanne Ludvigsen.

Conference on Quantum Optics, Mallorca, Spain, October 14 - 19, 2000; Ilkka Tittonen.

Cost 265-4rd MC Meeting, Bratislava, Slovac, October 21 - 24, 2000; Hanne Ludvigsen.

Meetings at DFM and COM, Lyndby, Denmark, November 16 - 23, 2000; Hanne Ludvigsen.

Visits by the laboratory personnel

Kaisa Nera to CNET, FranceTelecom, Paris, France, February 18, 2000.

Erkki Ikonen and Petri Kärhä to UME, Istanbul, Turkey, April 4, 2000.

Personnel of the laboratory, Tallinn Technical University and Kuberneetika AS Ltd, Tallinn, Estonia, June 19-20, 2000.

Petri Kärhä to NPL, London, United Kingdom, August 15, 2000.

Erkki Ikonen, Toomas Kübarsepp and Petri Kärhä to SP, Borås, Sweden, September 6, 2000.

Toomas Kübarsepp to Nederlands Meetinsituut, Delft, The Netherlands. November 20 – 22, 2000.

Research work abroad

Farshid Manoocheri, National Institution of Standards and Technology (NIST), USA, Aug 1 - Dec 31, 2000.

Goëry Genty, Technical University of Denmark, Lyndby, Denmark, October 24 - December 31, 2000.

Guest researchers

Sandrine Sigonneau, Ecole Supérieure d'Optique, Paris, France, June 1 - August 31, 2000.

Mr. Ondrej Cip and Mr. Josef Lazar, Institute of Scientific Instruments, Brno, Czech, September 25 - October 7, 2000.

Visits to the laboratory

Mr. Malcolm White, National Physical Laboratory NPL, London, United Kingdom, Jan 29 - Feb 1, 2000.

Mr. Ulf Leonhardt, KTH Stockholm, Sweden, March 20 - 21, 2000.

Mr. Otto Glatz, Coherent, Germany, May 2 - 5, 2000.

Mr. Lars Holm, Gamma Optronik Ab, Uppsala, Sweden, May 2 - 5, 2000.

Prof. David J. Richardson, Optoelectronics Research Centre, University of Southampton, United Kingdom, June 14, 2000.

Mr. Peter Blattner, EAM, Switzerland, June 14 - 16, 2000.

Dr. Howard Yoon, National Institute of Standards & Technology (NIST), Gaithersburg, USA, June 25 - July 1, 2000.

Dr. Yoshi Ohno, National Institute of Standards & Technology (NIST), Optical Technology Division, Gaithersburg, USA, June 29 - July 5, 2000.

Dr. Angus Bell, (MicroLase) Coherent, Scotland, July 24 - 28, 2000 and September 14 - 17, 2000.

Mr. Mart Noorma, University of Tartu, Department of Physics, August 17, 2000.

Dr. Olev Saks, Dr. Ivo Leito and M.Sc. Viljar Pihl, University of Tartu, Department of Physics and Chemistry, August 24, 2000.

Dr. Xu Gan, Singapore Productivity and Standards Board, Singapore, September 8 - 11, 2000.

Memberships

Helsinki University of Technology, Metrology Research Institute (represented by Erkki Ikonen) is a member laboratory of the Comite Consultative Photometrie et Radiometrie (CCPR).

EUROMET, Photometry and Radiometry, Erkki Ikonen [Rapporteur and Contact person].

European Cooperation for Accreditation (EA), Task Force: Photometry and Radiometry, Petri Kärhä (Member).

Advisory Commission for Metrology, Pekka Wallin (Member).

Advisory Commission for Metrology, Optical quantities expert group, Pekka Wallin (Chairman), Erkki Ikonen (Member).

Advisory Commission for Metrology, Expert group in length metrology, Erkki Ikonen (Member).

COST Action 265, Measurement techniques for active and passive fibres to support future telecommunications standardisation, Hanne Ludvigsen (Contact person of Finland).

Thematic Networks funded by the SMT Programme

HUT is the co-ordinator of the Thematic Network for Ultraviolet Measurements. The official part of this project ended on November 14, 2000.

HUT is a member and national co-ordinator of the Fibre Optic Technology Network (FOTON).

HELSINKI UNIVERSITY OF TECHNOLOGY (HUT)
HIGH VOLTAGE INSTITUTE (HVI)

QUANTITIES

Direct voltage	Alternating voltage	Capacitance	Loss factor tanδ
Inductance of high voltage reactors	Lightning impulse voltage	Switching impulse voltage	Other impulse voltages
Impulse current	Impulse energy	Impulse charge	

PERSONNEL

Martti Aro	Laboratory Director
Jari Hällström	Technical Manager
Marja-Leena Pykälä	Quality Manager
Esa-Pekka Suomalainen	Senior Research Scientist
Juri Chekurov	Research Scientist
Jukka Piiroinen	Research Scientist

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

Direct voltage	Voltage dividers, precision voltmeter, special software.
Alternating voltage	Standard gas capacitors, current comparator bridge, digitising precision voltmeter with special software, auxiliary divider.
Alternating current	Shunt resistors, Rogowski coil, digitising precision voltmeter with special software.
Capacitance	Standard capacitors, current comparator bridge.
Loss factor tanδ	Standard capacitors, current comparator bridge, auxiliary resistors, unit for eliminating the effect of the measuring cable resistance.
Inductance of high voltage reactors	Standard capacitors, standard coil, current comparator bridge, two digitising precision voltmeters with special software, current shunts.
Lightning impulse voltage	Impulse calibrator, voltage divider, digital recorder with special software.
Switching impulse voltage	Impulse calibrator, voltage divider, digitising precision voltmeter with special software.
Other impulse voltages	Impulse calibrator, voltage divider, digitising precision voltmeter with special software.
Impulse current	Shunt resistors, digital recorder with special software.
Impulse energy	Shunt resistors, digital recorder with special software.
Impulse charge	Reference calibrator, calibrated resistor, digital recorder with special software.

Maintenance

Apart from the regular upkeeping of the reference systems and the quality system, laboratory personnel has taken part on domestic and international working groups (CIGRE WG 33.03), preparation of standards (IEC TC 42), as well as domestic and international conferences and education days.

Development

Development of impulse measurements
The main emphasis was on preparation work for calibration of ESD- and EFT testers. The main instrumentation was verified and a study on ESD-testers currently used by Finnish industry was done. A 6 kV attenuator was calibrated carefully for EMC surge and it appeared being stable. ESD contact discharge calibration system was improved by a new target with larger bandwidth and calibration of the digitiser. The uncertainties of reference systems were reduced. System for attenuation monitoring of the ESD measuring system was developed. Capability for calibration services of ESD contact discharge (1-30 A) measurement is available. Comparison of the contact discharge of the most common ESD guns was completed. The differences were considerable. The poor repeatability of the air discharge requires a sampling frequency of at least 20 GS/s in single shot. Calibration capability for ESD impulse was established.

The lightning and swithching impulse voltage measurement software was updated, and the impulse voltage calibration capabilities was improved. Effect on interference on impulse current measurement has been reduced. Reparation of the lightning impulse voltage divider G600 was continued. The l.v. arm and the transmission cable were replaced. However, localising of the time parameter errors causing defect appeared very difficult. The uncertainties of the new impulse calibrators could be reduced.

Dynamic behaviour of reference shunts for impulse current measurements were determined by means of current step. Linearity tests were completed up to 10 kA. The uncertainty is not more than 3 % for peak current and 5 % for time parameters. Improving of the uncertainties should be continued.

Development of AC and DC measurements
Renovation of a calibration room for AC and DC quantities was under way in 2000. This work will enable us to make most AC and DC calibrations in one, well equipped environment.

The reference divider, based on compressed gas capacitor M150, was further improved. In stability monitoring a small gas leakage was found in the h.v. arm. This causes a small drift in the ratio, because the l.v. arm made of a ceramic capacitor appeared to be very stable. Also the phase displacement measurements can be made with the divider to some extent.

Uncertainties in measurement of large capacitances were reduced. Ceramic reference capacitors appear to be very stable. Finishing of comparison of large capacitance measurements with SP was delayed because of SP occupancy. An old 500 kV compressed gas capacitor was bought from KTH Stockholm, and it will be renovated.
A big effort was put on creating calibration capabilities for alternating current, and the uncertainties were reduced. Calibration services up to 5000 A can be started. The uncertainty is 0,05 % up to 2000 A and increases gradually up to 0,1 % at 5000 A.

Direct voltage calibration uncertainties were re-calculated, measurement software updated, and as result of these efforts lower uncertainties were reached. The measurements of 50 kV divider were continued and the uncertainty of 50 kV DC system was reduced down to 50 ppm. The 200 kV divider was also improved. Its uncertainty between 50 to 200 kV was reduced.

Both alternating current and new direct voltage uncertainties were verified by participating in international intercomparisons.

Intercomparisons

International comparisons

HUT High Voltage Institute has taken part in four intercomparison during this year, none of them are in final stage yet.

Euromet N:o	Time	Quantity	Participants	Coordinator	Status
488	2 July 1999 -	Lightning impulse voltage, 50 mV – 400 kV Switching impulse voltage, 50 mV – 300 V	FI IT AT GR DE SE FR ES NL CH PL RO RUS + 9 Non-European	FI (HUT)	Ongoing
	1 December 1999 -	Inductance (4 mH) Capacitance (50 µF)	SP	FI (HUT)	Ongoing
473	10 April – 26 April 2000	AC current 100 – 1200	GB SE BE DE PL HU IT CH FI AU	GB (NPL)	HUT/HVI measurements reported
495	26 June –14 July 2000	DC voltage 10 – 100 kV	DE GB IT SE FR CH FI	GB (NPL)	HUT/HVI measurements reported

International (EA or other) intercomparisons for accredited calibration laboratories

Some participants of Euromet 488 (see previous paragraph) are accredited calibration laboratories.

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

Rungis Juris, Aro Martti, Hällström Jari, et al: Use of Low Voltage Calibrators in Impulse Voltage Measurements. ELECTRA 189, April 2000, p. 83 - 109.

Conferences

M Aro: CIGRE biannual General Session, Paris 27 August – 1 September 2000.

Reports

Kalibrointikirjojen (RePe) täydennykset (DC, ACU, LCtanδ, LI, IC, ESD).

Aro Martti: Metrological Research and Development and Maintenance of National Standards at HUT High Voltage Institute in 1998. Finnish National Standards Laboratories FINMET. Annual Report 1999. Centre for Metrology and Accreditation, Publication J2/2000, pp. 67 - 74.

Suomalainen Esa-Pekka: Precision class of voltage transformer and rated burden (in Finnish). Sähkö&Tele 73 (2000) 1, p. 65.

Suomalainen Esa-Pekka: Accurate calibration system for voltage measurements up to 100 kV (in Finnish). Sähkö&Tele 73 (2000) 1, p. 66.

Hällström Jari (editor): Instruments and software used for measurement in high-voltage impulse tests. Final draft international standard. IEC 42/164/FDIS, 2000-09-22, 34 p.

Aro Martti (editor): Post graduate seminar. Special aspects of high-voltage and high-current measurements. Sjökulla 29 – 31 May 2000. Seminar Proceedings. Helsinki University of Technology, High Voltage Institute, Espoo November 2000, 228 p.

Chekurov Juri, Hällström Jari, Piiroinen Jukka: 50 kV DC voltage reference measuring system HUT 50. Helsinki University of Technology, High Voltage Institute, Report TKK-Sjt-40, Espoo Finland, December 2000, 18 p.

Intercomparison reports

Aro Martti: Traceability and mutual Recognition of Impulse Voltage Measurements. EU-Project SMT4-CT98-2270. Progress Report to EUROMET. Project 488, 23 February 2000, 2 p.

Aro Martti: Traceability and mutual Recognition of Impulse Voltage Measurements. Publishable Management report, project EU SMT4-CT98-2270. Helsinki University of Technology, High Voltage Institute, 6 July 2000, 6 p.

Aro Martti: Traceability and mutual Recognition of Impulse Voltage Measurements. Progress report 12/1999 to European Commission. CIGRE 33-00 (WG 03) 19, Dresden, September 4 - 7, 2000, 15 p.

Aro Martti: Traceability and mutual Recognition of Impulse Voltage Measurements. Management Report to European Commission 6 July 2000. CIGRE 33-00 (WG 03) 20, Dresden, September 4 - 7, 2000, 6 p.

Hällström Jari, Aro Martti: Traceability and mutual Recognizability of Impulse Voltage Measurements. Report of results of the first round. CIGRE 33-00 (WG 03) 58, Dresden, September 4 - 7, 2000, 18 p.

Chekurov Juri, Hällström Jari, Piiroinen Jukka: Comparison of DC voltage reference measuring systems of HUT and NPL. EUROMET Project 495: Comparison of voltage measurement at DC voltages up to 100 kV. Helsinki University of Technology, High Voltage Institute, Report TKK-SJT-39, Espoo Finland, Dec. 2000, 13 + 7 p.

Aro Martti: EUROMET intermediate report of project 488: Traceability and mutual Recognizability of Impulse Voltage Measurements. World wide intercomparison of impulse voltage measuring systems with digitizer and impulse calibrator. Helsinki University of Technology, High Voltage Institute, 29 December 2000, 2 p.

Hällström Jari: Traceability and mutual Recognizability of Impulse Voltage Measurements. World wide intercomparison of impulse voltage measuring systems with digitizer and impulse calibrator. Intermediate report on results of the first round. Project EU SMT4-CT98-2270. Helsinki University of Technology, High Voltage Institute, Draft October 2000, 97 p.

Aro Martti: Traceability and mutual Recognition of Impulse Voltage Measurements. Publishable Project Summary PPS, project EU SMT4-CT98-2270. Helsinki University of Technology, High Voltage Institute 29 December 2000, 1 p.

Aro Martti: Traceability and mutual Recognizability of Impulse Voltage Measurements. World wide intercomparison of impulse voltage measuring systems with digitizer and impulse calibrator. Progress report, project EU SMT4-CT98-2270. Helsinki University of Technology, High Voltage Institute, 29 Dec. 2000, 10 p.

Suomalainen Esa-Pekka: Comparison of current transformer, EUROMET 473. Report to coordinator NPL. Helsinki University of Technology, High Voltage Institute, 6 July 2000, 5 + 5 p.

Lectures

Prof. Geert Damstra from TU Eindhoven: Lessons in post graduate seminar on *Special aspects of high-voltage and high-current measurements* in Sjökulla 29 – 31 May 2000.

Martti Aro: Lessons in post graduate seminar on *Special aspects of high-voltage and high-current measurements* in Sjökulla 29 – 31 May 2000.
Jari Hällström: Lessons in post graduate seminar on *Special aspects of high-voltage and high-current measurements* in Sjökulla 29 – 31 May 2000.

Esa-Pekka Suomalainen: Lessons in post graduate seminar on *Special aspects of high-voltage and high-current measurements* in Sjökulla 29 – 31 May 2000.

Jari Hällström: Laboratory quality system at HUT HVI. Quality seminar at HUT on 29 November 2000.

Other activities

Domestic committees

M Aro: Chairman of Finnish National Committee of IEC TC 42 (High voltage testing techniques).

M Aro: Member of Finnish National Committee of CIGRE.

M Aro: Vice member of Finnish Advisory Commission for Metrology (MNK) put into action by Ministry of Trade and Industry.

M Aro: Member of the National Metrology Service Section of MNK.

M Aro: Member of advisory working group for electrical quantities of MNK.

J Hällström: Member of advisory working group for electrical quantities of MNK.

International committees

M Aro: Member of CIGRE Working Group 33.03 (High voltage testing and measuring techniques).

M Aro: Leader of Maintenance Group 13 of IEC 36B (Insulators for overhead lines) for revision of IEC Report 61211: Puncture testing on insulators. 19.9.2000 onwards.

M Aro: Responsible for Puncture tests and Generating circuits for very fast transients in CIGRE Task Force 33.03.02 (Very Fast Transients).

M Aro: Assessor of CMC data of high-voltage quantities in EUROMET from November 2000 on.

J Hällström: Acted as chairman of the editing committee for the new IEC Publication 61083-1 Instruments and software for measurements in high-voltage impulse tests.

J Hällström: Leader of IEC TC 42 Maintenance Team for the IEC Standard series 61083: Instruments and software for measurements in high-voltage impulse tests.

J Hällström: Member CIGRE Working Group 33.03

J Hällström: Leader of CIGRE Task Force TF 33.03.01 (Digital techniques in high voltage measurements).

International visitors

Prof Geert Damstra from TU Eindhoven: 26 May – 1 June 2000. Discussions. Lessons in post graduate seminar on *Special aspects of high-voltage and high-current measurements* in Sjökulla 29 – 31 May 2000.

3.7 FINNISH GEODETIC INSTITUTE (FGI) ACCELERATION OF FREE FALL

QUANTITIES

Acceleration of free fall

PERSONNEL OF THE LABORATORY

Jussi Kääriäinen	Professor, Chief of the Department for Gravimetry (until June 30)
Jaakko Mäkinen	Senior Research Scientist
Paavo Rouhiainen	Research Scientist
Hannu Ruotsalainen	Research Scientist
Heikki Virtanen	Research Scientist

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

The Finnish Geodetic Institute has two absolute gravity meters, JILAg-1 and JILAg-5. They track the free fall of a corner cube retroreflector in a vacuum chamber. Distance is measured by a laser interferometer and time is based on a rubidium standard.

Maintenance

The absolute gravimeter JILAg-5 has been used at the Metsähovi national reference station on 30 March – 1 April, 27 April – 3 May, 10–11 May, 25–26 May, 17–18 June, 12–13 July, 1–2 September, 29–30 October, 20 –22 November.

The frequency of the two mode laser (Laseangle RB-1 no.18) of JILAg-5 was compared with the metre laser of Helsinki University in the Kumpula accelerator laboratory on 1 February, 29 June, and 1 November. The frequency of the two mode laser (Laseangle RB-1 no.19) of JILAg-1 was compared with the metre laser of the Helsinki University in the Kumpula accelerator laboratory on 1 February, 29 June, and 3 November.

The rubidium frequency standards of the JILAg-5 and JILAg-1 (Efratom FRK-L numbers 8533 and 8514, respectively) were compared with the hydrogen maser oscillator of the Helsinki University of Technology on 30 March, 11 May and 18 June. They were compared with each other at every absolute measurement in Metsähovi. The Efratom FRK-L no. 8533 was also compared with the cesium beam standard of the German Fundamental Geodetic Station in Wettzell on 25 October.

The performance and calibration of the relative gravimeters LaCoste&Romberg nos. G-55 and G-600 have been monitored on the calibration line Masala-Vihti.

The superconducting gravimeter GWR T020 has recorded variations in gravity at the Metsähovi national reference station all year. Special attention has been paid to the influence of hydrological phenomena on gravity.

The national 5×5 km^2 gravity network was densified by 365 new gravity stations, measured with relative gravimeters.

The influence of the Fennoscandian postglacial rebound on gravity was studied by repeating the relative measurements on the land uplift gravity line along the latitude 65ºN between Kalajoki and Kuhmo. Four relative gravimeters were used in parallel.

The gravity difference over the postglacial fault in Pasmajärvi was measured with relative gravimeters for the

sixth time since 1987. No significant variation in the gravity difference has been observed in view of an uncertainty of about 0.05 μm s^{-2} per campaign.

Development

The sediment layers around the national reference station Metsähovi were mapped with gravimetric techniques in a grid of 740 points covering 200×200 m^2, in cooperation with the Geological Survey of Finland. This will help to relate observed variations in gravity to hydrological phenomena.

Intercomparisons

International comparisons

UNIGRACE first campaign and ICAG'97

In the first field campaign (1998-1999) of the project UNIGRACE (Unification of Gravity Systems in Central and Eastern Europe) five absolute gravimeters (see table) were compared at the stations Wettzell (Germany) and Jozefoslaw (Poland).

Gravimeter model and number	Operated by institute	Country
JILAg-6	Bundesamt für Eich- und Vermessungswesen	Austria
JILAg-5	FGI (Geodeettinen laitos)	Finland
FG5-206	Ecole et Observatoire des Sciences de la Terre, Université de Strasbourg	France
FG5-101	Bundesamt für Kartographie und Geodäsie	Germany
ZZG	Warsaw University of Technology	Poland

Results were published in the progress report delivered to the European Union [Unification of Gravity Systems in Central and Eastern Europe (UNIGRACE). Second twelve monthly progress report, from 01.01.1999 to 31.12.1999. Contract Number ERBIC15CT970805. Report issued on 29.01.2000]. This progress report also contains an excerpt of the yet-unpublished report of the International Comparison of Absolute Gravimeters [Robertsson, L. et al.: Fifth International Comparison of Absolute Gravimeters ICAG'97. Submitted to Metrologia, 2000].

In the ICAG'97 the offsets between the results of different instruments are consistent with the calculated uncertainties. In the UNIGRACE some larger offsets were observed. This is probably in part due to a variation in gravity at its comparison sites, Wettzell and Jozefoslaw. The measurements at them were spread out over more than 15 months. There is already a preliminary report [R. Falk, unpublished] which finds hydrological effects of up to 0.1 μm s^{-2} at Wettzell.

UNIGRACE second campaign

In the second campaign of UNIGRACE, the Finnish Geodetic Institute made absolute measurements with the JILAg-5 at the following sites

Country	Station	Dates
Poland	Krokowa	15–17 September 2000
Poland	Jozefoslaw	19–20 September 2000
Romania	Cluj	6–8 October 2000
Romania	Belis	10–11 October 2000
Romania	Constantza	18–19 October 2000
Germany	Wettzell	24–25 October 2000

At Jozefoslaw and Wettzell all participating gravimeters can be compared (see the Chapter UNIGRACE first campaign and ICAG'97). At Krokowa the result can be compared with that of the ZZG from the first campaign, and at the Romanian sites with the FG5-101.

The FG5-101 also visited the national reference station Metsähovi 15–19 June. Comparison measurements with the JILAg-5 were performed both at the main site AB (national number 951001) and the excentre AC (951002).

Between the UNIGRACE campaign stations, absolute measurements were made at the Polish national reference site Borowa Góra 22–23 September. This station was previously occupied by the JILAg-5 (in 1995) and by three other absolute gravimeters.

The results will be processed and reported in 2001.

International (EA or other) intercomparisons for accredited calibration laboratories

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

Lázaro C., Mäkinen J., Osório J., Bastos L., Baptista P., Hein, G. (2000): Precise gravity measurements in Azores Islands. In B. Ducarme and J. Barthélemy (eds): Proceedings of the Workshop: High Precision Gravity Measurements with Application to Geodynamics, and Second GGP Workshop. Munsbach Castle (Grand Duchy of Luxembourg), March 24th to 26th. *Cahiers du Centre Européen de Géodynamique et de Séismologie*, vol. 17, 229–238.

Nawa K., Suda N, Fukao Y., Sato T., Tamura Y, Shibuya K, McQueen H., Virtanen H, Kääriäinen J. (2000): Incessant excitation of the Earth's free oscillations, global comparison of superconducting gravimeter record. *Phys. Earth Planet. Interiors* 120, 289–297.

Virtanen H. (2000): On the observed hydrological environmental effects on gravity at the Metsähovi station, Finland. In B. Ducarme and J. Barthélemy (eds): Proceedings of the Workshop: High Precision Gravity Measurements with Application to Geodynamics, and Second GGP Workshop. Munsbach Castle (Grand Duchy of Luxembourg), March 24th to 26th. *Cahiers du Centre Européen de Géodynamique et de Séismologie,* Vol. 17, 169–175.

Conferences

Korhonen J. V., Aaro S., All T., Chepik A., Elo S., Haller L.-Å., Kulinich A., Kääriäinen J., Mäkinen J., Ruotsalainen H., Sildvee H., Skilbrei J. R., Solheim D., Vaher R., Zhdanova L. (2000): Bouguer anomaly map of the Fennoscandian Shield 1:2 000 000. Gravity, Geoid and Geodynamics 2000, July 31–August 5, 2000, Banff, Alberta, Canada. (Abstract).

Virtanen H. (2000): On the local temporal variations of the gravity field observed by superconducting gravimeter GWR T020. EGS XXV General Assembly, Nice, France, 25–29 April 2000. Geophysical Research Abstracts, Vol. 2 (Abstract).

Virtanen, H. (2000): Hydrological Studies at the Gravity Station Metsähovi in Finland. The 14th International Symposium on Earth Tides (ETS 2000), August 28–September 1, 2000, Mizusawa, Iwate, Japan (Abstract).

Reports

Mäkinen J., Ruotsalainen H., Virtanen, H. (2000): National Report for Finland. Nordic Geodetic Commission, Working Group for Geodynamics. Onsala, November 7 to 8, 2000. http://www.oso.chalmers.se/~hgs /NKGWG/Docs/.

Intercomparison reports

Unification of Gravity Systems in Central and Eastern Europe (UNIGRACE). Second twelve monthly progress report, from 01.01.1999 to 31.12.1999. Contract Number ERBIC15CT970805. Report issued on 29.01.2000.

Lectures

Other activities

Jussi Kääriäinen was a member of the Advisory Commission for Metrology (ACM) and a member of the expert group for mass and derived quantities within ACM.

Jaakko Mäkinen was a member of the expert group for mass and derived quantities within ACM.

Jaakko Mäkinen is a member of the Working Group 6 “Intercomparison of Absolute Gravimeters” (WG6) of the International Gravity and Geoid Commission (IGGC) of the International Association of Geodesy (IAG).

On October 6 Dr. Leonid F. Vitushkin, Senior physicist, Mass section, BIPM, Chairman of WG6 (“Intercomparison of Absolute Gravimeters”) of the IGGC visited the Finnish Geodetic Institute and the Metsähovi gravity laboratory. The visit was connected with a plan to invoke the CIPM in the future in international comparisons of absolute gravimeters, which so far, although sponsored by and arranged at the BIPM, have taken place under the auspices of the IGGC and its precedessor (International Gravity Commission. IGC). A secondary purpose was to inspect the Metsähovi gravity laboratory of the Finnish Geodetic Institute, which has been proposed as a center for regional comparisons (Northeast Europe).

FINNISH GEODETIC INSTITUTE (FGI)
LENGTH

QUANTITIES

Length

PERSONNEL

Jorma Jokela	Research Scientist, Department of Geodesy - standard and calibration baselines, EDM, calibration
Markku Poutanen	Research Scientist, Department of Geodesy - standard and calibration baselines
Paavo Rouhiainen	Research Scientist, Department of Gravimetry - rod calibration
Mikko Takalo	Research Scientist, Department of Gravimetry - rod calibration

In the end of 2000, Prof. Jussi Kääriäinen, Head of the Department of Gravimetry and Head of the National Standards Laboratory, and Prof. Martin Vermeer, Head of the Department of Geodesy, are not anymore in the service of the FGI.

RAELISATION, MAINTENANCE AND DEVELOPMENT

Realisation

Absolute calibrations of quartz gauges using internationally recommended laser wavelength standards (PTB, MIKES).

Maintenance of quartz gauge system by comparisons (Tuorla Observatory, University of Turku).

Interference measurements with the Väisälä comparator (Nummela Standard Baseline).

Maintenance

In 2000, absolute calibrations were performed in the Centre for Metrology and Accreditation (MIKES) for quartz gauges nos. VIII, 49, 50 and 51. These, and nos. 30 and 54 were used in the comparisons in the Tuorla Observatory, where the quartz gauge no. 29 is the principal normal.

The joint project between the FGI, the National Bureau of Surveying and Mapping in China (NBSM) and the Sichuan Bureau of Surveying and Mapping (SBSM) to measure the Chengdu Standard Baseline with the Väisälä interference comparator and high precision EDM was completed.

The interference observations at the Gödöllő Standard Baseline (in Hungary) in 1999 were processed, and the cooperation in length metrology with the Institute of Geodesy, Cartography and Remote Sensing (FÖMI) was continued.

Cooperation with the Estonian Land Board (Maa-amet) was continued. The Vääna-Jõesuu geodetic control baseline (in Estonia) was measured with high precision EDM in October.

The Nummela Calibration Baseline was re-measured with high precision EDM instruments in September - October.

The Kern Mekometer ME5000 of the Helsinki University of Technology has been used in many of our high precision EDM projects. This instrument was last calibrated at the Nummela Standard Baseline in October. The Distomat Wild DI2002 of the FGI was calibrated there in September - October. Projection measurements between the underground markers and observation pillars of the Nummela Standard Baseline were performed two times in September - November.

The instrumentation and computer programmes of the vertical laser rod comparator have been further improved. Levelling rods from Lithuania and from the cities of Kajaani and Turku have been measured and their thermal coefficients determined.

Development

The FGI participated in the absolute calibration project of quartz gauges. The project was carried through in the Centre for Metrology and Accreditation (MIKES).

Intercomparisons

International comparisons

International (EA or other) intercomparisons for accredited calibration laboratories

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

Conferences

M. Takalo: Error sources in rod calibration. K. Schnädelbach, M. Schilcher (ed.): Ingenieurvermessung 2000, pp. 425-432. XIII International Course on Engineering Surveying, Munich, Germany, March 13-17, 2000.

Reports

J. Jokela, M. Poutanen, J.Z. Zhao, W.L. Pei, Z.Y. Hu and S.S. Zhang: The Chengdu Standard Baseline. Publications of the Finnish Geodetic Institute, no. 130. Kirkkonummi 2000. 46 p.

M. Takalo: On Automation in Precise Height Determination. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series Ci 119. Espoo 2000. 28 p.

M. Takalo: Experiences of Automated Calibration of Levelling Rods in Finland. Finnish Journal of the Surveying Sciences, vol. 18 (2000), no. 1-2, pp. 18-26.

M. Takalo: Tarkan korkeudenmäärityksen automaatiosta. Lectio Praecursoria, August 25, 2000. Maanmittaus, vol. 75 (2000), no. 1-2, pp. 60-64.

Intercomparison reports
Lectures
Other activities

3.8 RADIATION AND NUCLEAR SAFETY AUTHORITY (STUK) RADIATION PRACTICES REGULATION, RADIATION METROLOGY LABORATORY

QUANTITIES

Air kerma	Reference air kerma rate	Absorbed dose to water	Ambient dose equivalent
Directional dose equivalent	Personal dose equivalent	Surface emission rate	

PERSONNEL OF THE LABORATORY

Hannu Järvinen	Physicist, Head of the Laboratory
Antti Kosunen	Senior Physicist
Petri Sipilä	Senior Physicist
Ritva Parkkinen	Physicist
Ilkka Jokelainen	Physicist
Harri Lindroos	Technician
Ilkka Aropalo	Technician
Carita Ruuhonen	Secretary

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation

Air kerma, absorbed dose to water, ambient dose equivalent, directional dose equivalent, personal dose equivalent: Secondary standard ionisation chambers with ^{60}Co and ^{137}Cs gamma sources and X-ray sources (10-320 kV X-ray equipment). Secondary standard beta ray sources extrapolation ionisation chamber (primary standard for dose equivalents of beta rays). Secondary standard neutron sources (for dose equivalents of fast neutrons).

Reference air kerma rate (for brachytherapy sources of ^{60}Co, ^{192}Ir and ^{125}I): Secondary standard well-type ionisation chamber.

Surface emission rate: wide area secondary standard sources of beta nuclides (^{90}Sr/^{90}Y, ^{36}Cl, ^{14}C) and an alpha nuclide (^{241}Am).

Maintenance

The quality of all equipment used for calibration and testing was controlled regularly according to a documented quality control programme. The stability of secondary standards remained good. The established action levels for stability test results were not exceeded. A new primary electronics for measurement of ionisation current was taken into use. For X-ray calibrations calibration method based on the use of a monitor ionisation chamber and constant source-to-chamber distance was taken into use.

Development projects

The Quality System of the laboratory was developed in accordance with the general guidelines given by the International Atomic Energy Agency (IAEA) for the Secondary Standard Dosimetry Laboratories (SSDLs) of the IAEA/WHO international network of SSDLs (WHO: World Health Organization).

The methods of measurement and calibration, for boron neutron capture therapy (BNCT), were studied. The laboratory participated in an EU funded Shared Cost Action under the Standards, Measurement and Testing Program, for 1998-2001. The aim of the project is to develop a European Code of Practice for BNCT dosimetry. Eleven partners from seven countries are participating in the project.

Three other research projects related to radiation metrology deal with development of comparative methods of measurements for radiotherapy (1996-2001) and quality assurance of electronic portal imaging devices (EPID-systems; 1998-2001; in collaboration with radiotherapy department of Tampere University Hospital).

Intercomparisons

International comparisons

The laboratory participated in the routine annual intercomparisons organised by the IAEA, using mailed thermoluminescent dosimeters, for the accuracy of therapy level air kerma or absorbed dose measurements among the 72 SSDLs of the IAEA/WHO network. The deviations of the values given by the laboratory from the reference values of the IAEA were –0.1 % (therapy level, ^{60}Co gamma beam) and from –1.1 % (therapy level, high-energy photon beams). All results are well within the action level of 3.5 % used by the IAEA.

Euromet-RAD project 526 "Calibration of dosimeters used in mammography with different X-ray qualities (tube voltages from 20 keV to 50 keV)" started in December 2000. Fourteen laboratories from thirteen countries are participating in this project. The calibrations for the intercomparison are expected at STUK in autumn 2001.

EA interlaboratory comparison number IR3 (Calibration of a Radiation Protection Dosimeter) was launched in May 2000. Fifteen laboratories and countries are participating in this comparison. Calibrations at STUK will be performed in spring 2001.

International (EA or other) intercomparisons for accredited calibration laboratories

See previous Chapter for EA IR3 comparison.

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

Conferences

Hannu Järvinen, Petri Sipilä and Ritva Parkkinen participated in the 19th ESTRO Annual Meeting in Istambul, Turkey. September 2000. Proceedings in Radiotherpy and Oncology 56, Suppl 1 (p. 199): Parkkinen R., Kosunen A., Sipilä P. and Järvinen H., *Implementation of the IAEA TRS 381 for the electron beam calibration of plane parallel ionization chambers in Finland*. Sipilä P., Järvinen H., Jokelainen I. and Parkkinen R., *Practical experiences of using a well chamber*.

Reports

De Almeida C., DeWerd L., Järvinen H., Soares S., Tölli H. Guidelines for the calibration of low energy photon sources and beta-ray brachytherapy sources, SSDL Newsletter no 43, July 2000. IAEA.

Shulin L., Morales J., Järvinen H. , Sedat Y., Gutt F., Meghzifene A. Development of a Quality Assurance Programme for SSDLs, SSDL Newsletter no 42, January 2000. IAEA.

Intercomparison reports

IAEA TLD comparisons reported directly only to the participants (see Chapter International comparisons).

Lectures

Antti Kosunen, *Radiation protection measurements*. National Training Course on Radiation Protection. Tampere, Finland. October 2000.

Hannu Järvinen, *Quality systems of Radiotherpy*. Baltic Oncology Meeting. Tallinn, Estonia. April 2000.

Other activities

The laboratory is a member of the IAEA/WHO International Network of the SSDLs.

Hannu Järvinen is a member of a Report Committee ”Dosimetric procedures in diagnostic radiology” of the International Commission on Radiation Units and Measurements (ICRU).

Hannu Järvinen is a member of the Physics Committee of the European Society for Therapeutic Radiology and Oncology (ESTRO).

Petri Sipilä is a member of the International Electrotechnical Commission (IEC) 62C WG1 and Antti Kosunen a member of IEC 62C WG3.

Hannu Järvinen participated in a project meeting of ESTRO-EQUAL TLD-dosimetry meeting aiming for development of audit systems for radiotherapy clinics. April 2000.

Hannu Järvinen visited the SSDL of Belorussia as a technical expert of the IAEA. September 2000.

Antti Kosunen and Hannu Järvinen participated in contact persons meeting of Euromet-RAD in Oslo, Norway. May 2000.

Hannu Järvinen and Antti Kosunen participated in the dosimetry meeting of SSDLs of the Nordic countries in Oslo, Norway. May 2000.

Antti Kosunen visited as a technical expert (invited by SWEDAC, Sweden) in the evaluation of the National Ionising Radiation Dosimetry Laboratory of Sweden (SSI). December 2000.

Ritva Parkkinen participated a ESTRO Training Course on Intensity Modulated Radiotherapy, Amsterdam, Netherlands. May 2000.

Petri Sipilä, Ilkka Jokelainen and Ritva Parkkinen visited as technical experts the Lithuanian radiotherapy clinics (IAEA mission). March and November 2000.

Petri Sipilä, Ilkka Jokelainen and Ritva Parkkinen visited as technical experts the Estonian (Tallinn) radiotherpay clinics (IAEA mission). February 2000.

Laboratory organized a training course on basics of radiotherpay dosimetry (together with Tampere University Hospital). Pikonlinna Tampere. October 2000.

Laboratory participated as teachers in the training course for radiation protection for custom officers of Baltic countries. STUK. March 2000.

Laboratory staff visited the European Workshop on Individual Monitoring of External Radiation organised by STUK. Helsinki, Finland. September 2000.

4. ACTIVITIES OF THE CONTRACT LABORATORIES IN 2000

4.1 RAUTE PRECISION OY FORCE AND MASS LABORATORY

QUANTITIES

Force	Torque

PERSONNEL

Aimo Pusa	Head of the Laboratory, K019
Mikko Mäntylä	Supervisor
Rami Lehto	Technician

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation, traceability

Force: The force scale is realised on the range 1 N …. 100 kN by dead weight standard machine, the range over 100 kN up to 1,1, MN is realised by hydraulic amplified machine, whereby the 100 kN dead weight standard machine is the reference machine. Realisation is based on the formula

$$F = m \cdot g_l \, [\, 1 - (\rho_a / \rho_m)\,].$$

The traceability of masses leads to Centre of Metrology and Accreditation (MIKES) in Finland and to PTB (Physikalisch-Technische Bundesanstalt, Germany). The gravity constant is determinate by Finnish Geodetic Institute.

Torque: The torque is realised by force and length, $M = F \cdot l$. The traceability of forces is described in section before. The traceability in the length leads to MIKES, which is the national laboratory for the length.

Maintenance

Regularly internal comparison measurements have been made. Internal cross check and routine testing has indicated a normal condition of standards during the year.

Development projects

The new torque standard for range less than 10 Nm is tested by participating the T2 EA-intercomparison for torque. The preliminary results demonstrated uncertainty of $3 \cdot 10^{-5}$.

Intercomparisons

International comparisons

Key comparison CCM.F-K1.a (range 5 kN and 10 kN) and CCM.F.K1.b (5 kN) has been started in February and during the year 11 laboratories have made the measurement. 5 laboratories have to do the measurement in year 2001.

EA-intercomparison T2 for Torque. This intercomparison was in laboratory during August 2000. To measure were transducers 10 Nm, 100 Nm, 500 Nm, 1000 Nm and 2000 Nm. The Pilot for the intercomparison is PTB and four of the transducer is owned by MIKES (100 Nm … 2000 Nm). The project is still in going and there is no report

available.

International (EA or other) intercomparisons for accredited calibration laboratories

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications

Conferences

IMEKO XVI World Congress, Wien, Austria.

Reports
Intercomparison reports

Lectures

For AEL 4 lectures, subject calibration technology and uncertainty of calibration.

“Calibration”, Ilomantsi, PKAKK.

“Strategy and development of the national metrology”, Metrology Seminar, Helsinki.

”Appropriate measurement”, Measuring 2000, Helsinki.

“Practical measurement with traceability and uncertainty”, Finnish Air Force, Tampere.

“Metrology in standards”, TAY-seminar of SFS, Helsinki.

Other activities

EUROMET mass contact persons meeting, February, Helsinki.

EA-mass expert group meeting, September, Turin.

Member of the VAT-measurement group for AEL (development of the education in the metrology).

Standardisation
Member of the translating group for force measurement standards,
co-operation with SFS for metrological aspects in standardisation.

Visits
OFMET-laboratory, May, Bern, Switzerland.
SP-Borås, March, Sweden.

Visitors
H. Källgren, SP-Borås, Sweden.

4.2 TAMPERE UNIVERSITY OF TECHNOLOGY (TUT) INSTITUTE OF PRODUCTION ENGINEERING

QUANTITIES

Dimensional quantities measured by Co-ordinate Measuring Machine (CMM)	Site calibrations of CMMs and Machine Tools

PERSONNEL OF THE LABORATORY

Heikki Tikka	Professor, Head of the Laboratory, K003
Paul H. Andersson	Professor, Substitute of K003
Olli Pirttiniemi	Special laboratory, Technician
Timo Anttila	Laboratory Engineer

REALISATION, MAINTENANCE AND DEVELOPMENT

Realisation, traceability

The Co-ordinate Measuring Machine (CMM) SIP CMM5 used as reference measuring machine is calibrated by gauge blocks, step gauge and by ball plate.

The calibration of the Reference Step Gauge is done by DKD in Zeiss Oberkochen. Gauge Blocks are calibrated by the Centre for Metrology and Accreditation (MIKES) as well the reference spheres. For the substitution method also some other reference objects are calibrated in Finland. The ball plate is calibrated by using Pkal software from PTB in so called swing around method.

Maintenance

The new CAD-based measuring software for SIP CMM5 called WiniSIP is installed and taken into use. Also two additional packages one for involute gear measurement (WiniGear) and one for threads (WiniPitch) are installed.

To calibrate CMM by Ball- or Hole Plates using a software called Kalkom from PTB is taken into use.

Development

Three years TEKES project is running. The topic is how to increase the quality by measuring dimensions like elastic plastics as well injection moulding. A Multi Sensor CMM from Mahr OMS 1000 with CCD camera and laser distance measurement was installed beginning of year 2000. This Multi Sensor CMM will be used for research and measurement of elastic plastic parts. There is organised a comparison for optical video CMMs in Finland. While this work is still running results can not be published yet.

A MIKES project calibration of a ball plate by swing around method and PTB PKAL program is finished and taken into use in the laboratory.

A MIKES project to calibrate a CMM by PTB KALKOM software by using a ball plate to is finished and taken into use in the laboratory.

EC project called Easytrac did start. It will last three years. The tasks of K003 are to test different kind of new calibration methods as well develop thread and bevel gear measurements by CMM.

Intercomparisons

International comparisons

EA M22 Taper Gauges, 2 inside 2 outside, Half angle and diameter
Dates 12 – 17 October 2000.
Calibration by SIP CMM5, 3D-CMM.
RESULTS:
Final report not published.

NIF (Nordic) K3 Comparison of threads
M36 6g and M20 6H, spring time 2000.
Measured by SIP CMM5 by WiniPitch a CAD-based software.
RESULTS:
The pitch diameters reported were close to correct values specially for external thread. Deviation was + 1.7 µm by uncertainty of 7 µm. The EN value was 0.24. For the internal thread result was + 4 µm but the uncertainty was big like 60 µm.

International (EA or other) intercomparisons for accredited calibration laboratories

National intercomparisons for accredited calibration laboratories

PUBLICATIONS, CONFERENCES, REPORTS, LECTURES AND OTHER ACTIVITIES

Publications
Conferences

Reports

TUT Publication no 314 (Dissertation) F. Jerabeck, ”Analysis of Single Flank Test Results Providing Flank Topography Errors of Spiral Bevel Gears”, ISBN 952-15-0512-5.

Intercomparison reports

Lectures

Heikki Tikka: ”Digitising of items”, Seminar for tool makers and research in Naantali Finland, 28 January 2000.

Heikki Tikka: ”Co-ordinate Measuring Machine – Possibilities, Techniques and Calibration” Organised by Continuing Training Centre for Adults in Tampere Finland, 8 March 2000.

Paul H. Andersson: ”The Future Trends of Calibration Laboratory at TUT”, Seminar organised by MIKES in Helsinki Finland, 21 March 2000.

Heikki Tikka: Lectures and organising the 9th meeting and laboratory works of CMM User Club in Finland, 3 May 2000.

Heikki Tikka: ”Co-ordinate measurement” Symposium Measurement 2000 organised by MIKES in Helsinki Finland, 9-10 May 2000.

Heikki Tikka. ”Picture analysis in measurement and calibration of dimensional quantities”, Seminar on Measurement in Production, Majvik Finland, 25 May 2000.

Heikki Tikka: ”Video optical dimensional measurement” Summer school on design, production and research of Plastics, Keuruu Finland, 8-9 June 2000.

Filip Jerabek: ”Analysis of Single Flank test results providing topography errors of spiral bevel gears“, Baltimore USA, ASME 2000 Design Engineering technical conference, 10-13 September 2000.

Gabor Szanti: “Uncertainty of Double Curved Surface by VCMM”, Krakow 2nd International conference of machining and measurement of Sculptured Surfaces, 20-22 September 2000.

Paul H. Andersson: “Accuracy of Machine Tools depending of the Positioning Measurement System and the Thermal State”, IMEKO 2000 World Congress, Vienna, 25-28 September 2000.

Filip Jerabek: (PhD) ”Analysis of Single Flank Test Results Providing Flank Topography Errors of Spiral Bevel Gears ISBN 952-15-0512-5, 8 December 2000.

Other activities

Training and visit at Mahr Multisensor GmbH Wadgassen, 10-16 January 2000.

Kick-Off meeting of EC-project Easytrac in Bilbao Spain on 14 April 2000, 13-16 April 2000.

Pavel Skalnik from CMI Czech Metrological Institute from Prague visited our laboratory. Exchange of SIP users. 12-14 June 2000.

2nd Project meeting of EC Easytrac in Prague CMI on 3 November 2000. At the same time exchange of experience over WiniSIP during the visit at CMI, 2-5 November 2000.

Visiting PTB Germany. Comparison of Bevel Gear measurement and testing the Virtual Co-ordinate measurement (VCMM), 27-31 March 2000.

Participating the Work Shop on Multi Beam Laser in Graz Austria, 13-14 November 2000.

Visiting CENAM in Mexico. 27 November – 1 December 2000.

A member of IMEKO TC 14 and Advisory Commission for Metrology.

Julkaisut 1999 - 2001

J1/1999	Nordic Intercomparison in Barometric Pressure
J2/1999	Automaattisten punnustenvaihtimien suunnittelu, toteutus ja käyttö
J3/1999	Intercomparison of Gauge Pressure Measurements between SP/FFA and MIKES in the Range 32 kPa ... 132 kPa
J4/1999	Ainemäärän kansallisen mittanormaalijärjestelmän toteuttamista ja organisaatiota koskeva selvitys
J5/1999	Mikrobiologisen metrologian tilanneselvitys ja kehittämissuunnitelma
J6/1999	Finnish National Standards Laboratories FINMET. Annual Report 1998
J7/1999	Lämpötilan vertailumittaus L10, S-tyypin termoelementin kalibrointi
J8/1999	Mekaanisten värähtelyiden mittausten kartoitus
J9/1999	Intercomparison of the Hydrometer Calibration Systems at the IMGC and the MIKES
J10/1999	National Basis for Traceability in Humidity Measurements
J1/2000	Intercomparison of Temperature Standards of Lithuania and Finland
J2/2000	Finnish National Standards Laboratories FINMET. Annual Report 1999
J3/2000	Mass Comparison M3
J4/2000	Mass and Volume Comparisons at MIKES
J5/2000	Nanometritason mittaukset, kartoitus
J6/2000	Nordic Intercomparison in Gauge Pressure Range 0 ... 2 MPa
J1/2001	Mikrobiologian kvantitatiivisten viljelymääritysten mittausepävarmuus
J2/2001	Finnish National Standards Laboratories. Annual Report 2000

Tilaukset toimistosihteeri Kirsi Tuomisto, puh. (09) 6167 457,
e-mail kirsi.tuomisto@mikes.fi.

MITTATEKNIIKAN KESKUS
CENTRE FOR METROLOGY AND ACCREDITATION
P.O. Box 239
FIN- 00181 HELSINKI
Tel. +358 9 616 761
Telefax +358 9 616 7467

ISBN 952-5209-56-3
ISSN 1235-5704