

Danish Institute of Fundamental Metrology

Annual Report and Statement of Income for 1999

Edited by

Jes Henningsen, Bendt Gerhardt and Kim Carneiro

Danish Institute of Fundamental Metrology
Building 307, Anker Engelunds Vej 1
DK 2800 Lyngby, Denmark

DFM-2000-R1
0209 JH
07-03-00

Telephone 4593 1144
Telefax 4593 1137

Mission

*As Centre of Excellence in metrology the Danish Institute of Fundamental Metrology ensures
that measurement knowledge in Denmark is continually developed and maintained at an in-
ternational scientific level*

and

that the Danish effort in fundamental metrology is coordinated

Table of Content

1. Report from the Institute	1
2. Reports from the Sections.....	2
2.1 Research	2
2.2 Calibration	4
2.3 Consulting	5
2.4 Administration	7
2.5 Marketing	7
3. Metrology in Denmark.....	8
3.1 Danish Institute of Fundamental Metrology - DFM	9
3.2 Centre of Danish Fundamental Metrology - CDFM	10
3.3 DANIAmet	10
3.4 Reference Laboratories outside of DANIAmet	12
3.5 The 10 subject fields of metrology.....	15
4. Key Figures	17
5. Accounts of Particular Activities.....	18
6. Statement of Income 1999 (in Danish)	26
6.1 Anvendt regnskabspraksis	26
6.2 Resultatopgørelse.....	27
6.3 Balance pr. 1999-12-31.....	28
6.4 Direktionens underskrift.....	28
6.5 Bestyrelsens underskrifter	29
6.6 Revisionspåtegning	30
6.7 Noter	31
7. How to get to DFM.....	32

The cover picture shows one of DFM's primary standards for length, a green Helium-Neon laser stabilised to a hyperfine transition in the Iodine molecule

1. Report from the Institute

In 1999 the Danish Institute of Fundamental Metrology continued the developments from the previous two years with increased focus on clients, while keeping a sound scientific basis. It resulted in the greatest income from clients in the history of DFM as well as the highest number of scientific publications. This is in accordance with the strategy plan for the period 1997-1999 that formed the basis for the three year contract with the Danish Agency for Trade and Industry. Further, in 1999 important steps were taken towards a new building with laboratory facilities.

As the core national metrology institute within the decentralised Danish metrology organisation DFM is engaged in the development and maintenance of measurement standards in the fields of mass, electricity, length as well as photometry and radiometry. Research is performed in support of these activities. Dissemination of traceable measurements is carried out under DANAK accreditation (registration number 255). Knowledge transfer is made through teaching and consulting. Our total quality system is in accordance with ISO 9001 (DS certificate no 623).

DFM has increased its national visibility significantly. A Centre for Danish Fundamental Metrology CDFM has been formed to coordinate the development within Denmark, and within DANIAmet the collaboration has continued. About 200 people now attend our courses for Danish clients, and our work for private companies has increased.

DFM continues to maintain a high international profile, with Danish participation in three of the ten consultative committees under the International Committee for Weights and Measures. Work for foreign clients has become a major activity, particularly relating to the build up of metrology in Central and Eastern Europe.

Looking ahead DFM has formulated a strategy for the period 2000-2002 which is the basis for a new contract signed with the Agency for Trade and Industry. In this connection a vision for the period has been formulated as follows:

*DFM will reinforce its international position of strength within scientific metrology
through an increased collaboration with Danish research institutions
and*

*The decentralised Danish metrology organisation will develop in a coordinated way
for the benefit of end-users and the satisfaction of the engaged laboratories*

Hence, DFM intends to continue the positive development of the past with particular focus on collaboration with Danish institutes within science and metrology. A major challenge is to operate DFM without the economic loss that has characterised the preceding years, since the reserve funds that had been accumulated are now depleted.

Steen Konradsen

Chairman

Kim Carneiro

Director

2. Reports from the Sections

2.1 Research

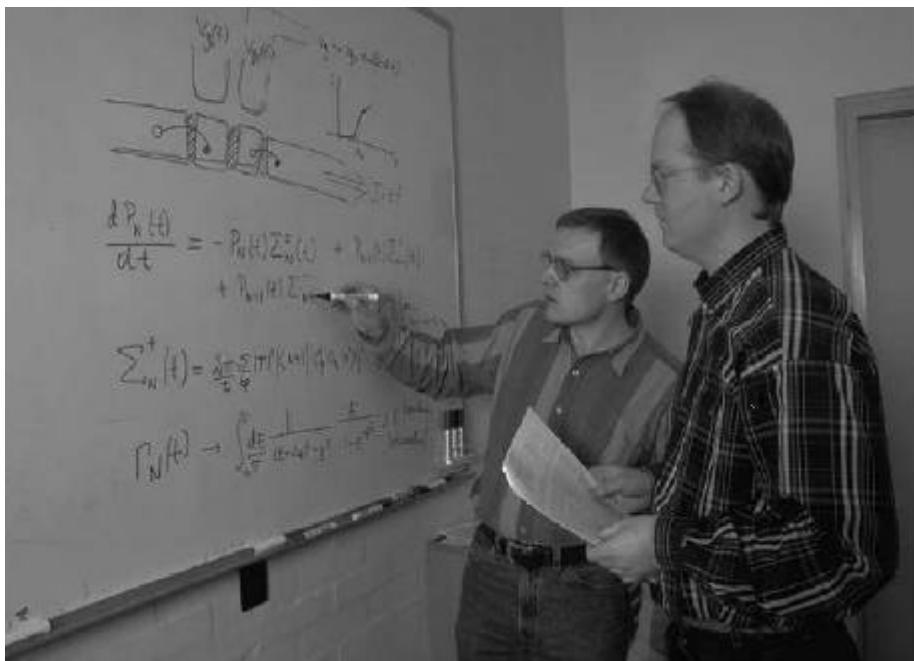
The research section is responsible for the development and maintenance of standards which are necessary to keep Denmark at an international level in metrology, and to generate the metrological knowledge requested by Danish industry.

In 1999 a total of 23 papers have been published in international refereed journals and the staff has contributed 26 presentations at international conferences. In addition to the permanent staff, 1 postdoc, 3 PhD students and 1 MSc student have been associated with projects in electrical metrology (2), surface metrology (2), and optical metrology (1). The section has been involved in 5 EU supported projects, two of them with DFM as coordinator, and in a Danish centre focusing on surface metrology and functionality. Including postdocs and PhD students the section has engaged 9.4 person-years, representing a significant increase relative to 1998.

Electrical Metrology

DFM has developed a facility for the measurement of electrolytic conductivity to provide traceability in the characterisation of pure water. The facility, which is aimed at servicing the Danish pharmaceutical industry and Danish power plants, was accredited by DANAK in 1999, and a comparison with NIST (USA) and OMH (Hungary) has lead to a declaration of equivalence. DFM coordinates an EU funded project aiming at establishing traceability for certified reference solutions for industry.

A theoretical project on single electron tunnelling and related phenomena has been continued, and the feasibility of using single electron transport in a fundamental current standard has been studied within the framework of an EU project and in collaboration with Danish universities. The transport properties of mesoscopic superconductor to normal-metal junctions is studied jointly with the Technical University of Denmark, with support from the Danish Science Research Council. This study is of fundamental importance to the understanding of transport in small Josephson junctions and may lead to new superconducting devices.



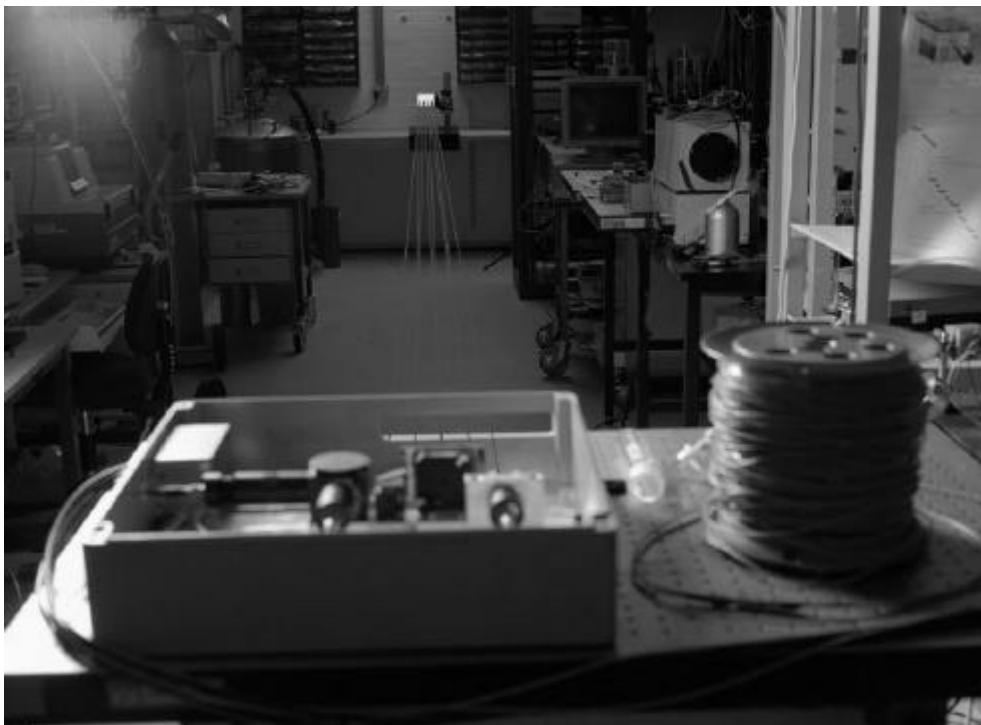
DFM collaborates with the Niels Bohr Institute within single electron tunnelling

Optical Metrology

DFM's activity in primary methods for metrology in chemistry has focused on the identification and elimination of error sources in spectroscopic measurements, and design of equipment for measuring hydrogen fluoride, an extremely poisonous gas which is present in the exhaust from power plants and incinerators. An EU supported project to develop a fibre laser system for monitoring H₂S and CO with diode lasers is near completion.

In radiometry, work has continued on adapting the primary standard for optical power, the cryogenic radiometer, to the ultraviolet (UV) wavelength region. DFM also participates in UV radiometry within the framework of an EU funded network with emphasis on the study of transfer standards for UV measurements.

In anticipation of substitution of today's primary length standards with iodine stabilised diode lasers, DFM has participated in an international comparison with eight different countries and the BIPM. Related work includes the development of optical wavelength standards for telecommunication, using molecular absorption lines and fiber optics technologies. This is pursued in collaboration with a Danish company *IONAS A/S* as well as within an EU supported network FOToN.



Within the framework of an EU collaboration DFM has contributed to the development of an optical fibre based monitor for hazardous gases

Mass and Surface Metrology

A multivariate method for uncertainty determination based on Lagrange multipliers has been developed, using a set of correlated model functions which describe the relations between input and output parameters. Also, a procedure for the evaluation of measurement results in key comparisons between national metrology institutes has been investigated.

As one of 13 partners in a Danish Centre for Surface Metrology and Functionality COMF, which was created during 1999, DFM works with the development of general equations and algorithms for calculation of correction parameters for atomic force microscopy. To demonstrate equivalence of measurements at an international level, DFM has participated in a comparison of line standards, and in collaboration with the company *Image Metrology ApS*, DFM participates in the development of advanced image processing software for scanning probe microscopy.

During the year, DFM has joined an ongoing EU project seeking to develop a basis for 3D surface roughness standards, and DFM's contribution will focus on topographical AFM measurements of selected substrates and determination of their roughness parameters.

2.2 Calibration

The responsibility of the Calibration Section is to maintain the Danish national standards for mass measurement, DC electricity (voltage, resistance, and reference solutions) length measurements, and optical radiometry, and to provide traceability to these standards through accredited calibrations. In addition, the section is responsible for internal technical activities. 3.8 person-years have been involved

Maintenance of standards

In 1999 DFM's accreditation was extended to include certification of reference materials for electrolytic conductivity with nominal values: 10 mS/m, 0.1 S/m, 0.14 S/m, 1 S/m and 1.2 S/m.

In order to demonstrate international equivalence, DFM participated in 6 international comparisons:

Length:

- EUROMET 413 - *Phase correction measurements in gauge block metrology*
- EUROMET 471 - *Short gauge blocks measured by interferometry*
- Bilateral comparison between DFM and MIKES (FI) of Iodine stabilised green HeNe lasers.

Radiometry:

- BIPM International comparison of cryogenic radiometers based on transfer detectors.

Electricity:

- EUROMET 429 *Comparison of 10 V DC reference standards*
- EUROMET 449 *Comparison of DC voltage ratios up to 1000 V*

Calibration Activities

During 1999, calibration activities covered

Electrical Calibration:

- 17 certificates for direct voltage (5), resistance (3), and reference solutions (9).

Optical Calibration:

- 18 certificates for length calibration (12 sets of gauge blocks) and optical power (6)

Mass Calibration:

- 14 certificates for sets of weights

Internal Technical Activities

Hardware upgradings have been performed of servers, PCs, electronic mail system, etc. in order to secure the stability of DFM's Local Area Network, and to eliminate the risk of "year 2000" problems. Also, upgrading of laboratory PCs to pentium has been completed.



DFMs activities in optical gauge block calibration for Danish and foreign clients have expanded during 1999

2.3 Consulting

The responsibility of the Consulting Section is to make the knowledge generated through DFM's activities in research and development of standards available to a broader community, encompassing Danish industry, laboratories, and public authorities. During 1999 the section had at its disposal 5.0 person-years.

The activities of the section are divided into the categories national and international cooperation, teaching, and client consultancy.

Cooperation

Denmark's status within the international metrological community has been upheld through Danish membership of several CIPM consultative committees and working groups:

- *Consultative Committee for Electricity and Magnetism (CCEM)*
- *Consultative Committee for Amount of Substance (CCQM)*
- *Consultative Committee for Acoustics, Ultrasound and Vibrations (CCAUV)*
- *Discussion Group on Nanometrology under the Working Group on Dimensional Metrology of the Consultative Committee for Length (CCL)*

An important part of DFM's international collaboration is carried out in EUROMET, the umbrella organisation of European National Metrology Institutes. EUROMET has subdivided metrology into 11 fields, and DFM contributes Danish contact persons to 8 of these. During 1999 DFM has participated in the yearly contact persons' meetings for mass, length, electricity, photometry and radiometry, amount of substance, and interdisciplinary metrology. The task of the contact persons is to transfer metrological knowledge from EUROMET to the relevant part of the Danish metrological community.

DFM has participated in the national metrological collaboration, in part through the Centre for Danish Fundamental Metrology (CDFM), and in part through DANIAmet. Within CDFM, a number of projects in fundamental metrology outside of DFM, which were initiated in previous years, were completed.

DFM has organised meetings in users groups for laboratory assessment, calibration of length, calibration of mass, and calibration of optical power and wavelength, and in reference groups for research in electrolytic conductivity in water and for single electron phenomena. The purpose of these groups is to inform

DFM's clients about the competences of DFM, and to provide DFM with input concerning future needs for services and research.

Teaching

As in previous years DFM has collaborated with DANAK concerning a series of courses in estimation of measurement uncertainty: The courses were intended for accredited laboratories working in the following areas:

- Microbiology (2 courses, 1 day each)
- Electrical Calibration (1 course, 2 days)
- Analytical Chemistry (1 course, 2 days)

To ensure uniform assessment of the uncertainty in accredited laboratories, DFM has also, in collaboration with DANAK, organised a 1-day brush-up seminar on uncertainty, aimed at DANAK's technical assessors. With the aim of broadening the technical expertise behind such courses a collaboration has been initiated with EUROLAB Denmark.

As an aid to clients who have chosen to use DFM's uncertainty software package DFM-GUM, DFM has organised four workshops, and four uncertainty courses have been tailor-made to specific enterprises. Two courses have been organised in good weighing practice, and DFM has together with IMGC, Italy, and NPL, United Kingdom, organised a series of workshops on strategic planning, aimed at the 13 Phare countries..



DFMs teaching activities have profited from improved facilities

Client Consultancy

On behalf of DANAK DFM has participated in the following international experts groups:

- EA Expert Group DC-LF
- EA Expert Group Mechanical Measurements

and DFM has assessed the technical competence of laboratories for the following accreditation bodies:

- DANAK (Denmark)
- UKAS (Great Britain)

- Norsk Akkreditering (Norway)

In contract with CEN-TCU, DFM has together with PTB (Germany), IMGC (Italy) og MIKES (Finland) performed a third round of assessment of the metrological infrastructure in the 13 Phare-countries. Also, DFM has evaluated applications from these countries for support in calibration of reference standards, and advised in connection with the organisation of proficiency testing in these countries.

2.4 Administration

During 1999 the section has had at disposal 3,1 person-years for administrative tasks; there is some increase in the administrative load compared to previous years, reflecting the greater technical activity.

The workplace environment has been improved through the purchase of combined height adjustable desks and computer tables for all staff members. Also, an auditorium has been furnished and fitted with a computer controlled large screen projector, leading to significantly improved conditions for teaching activities at DFM premises.

Initial steps have been taken to introduce electronic filing at DFM. In the beginning of 1999, the software package PC-doc was purchased, and after installation it has been modified in collaboration with the supplier to suit DFMs needs and the system is expected to be operational in 2000. Accounting has proceeded smoothly during the year, and work on bringing DFMs quality manual on electronic form was completed late in 1999.

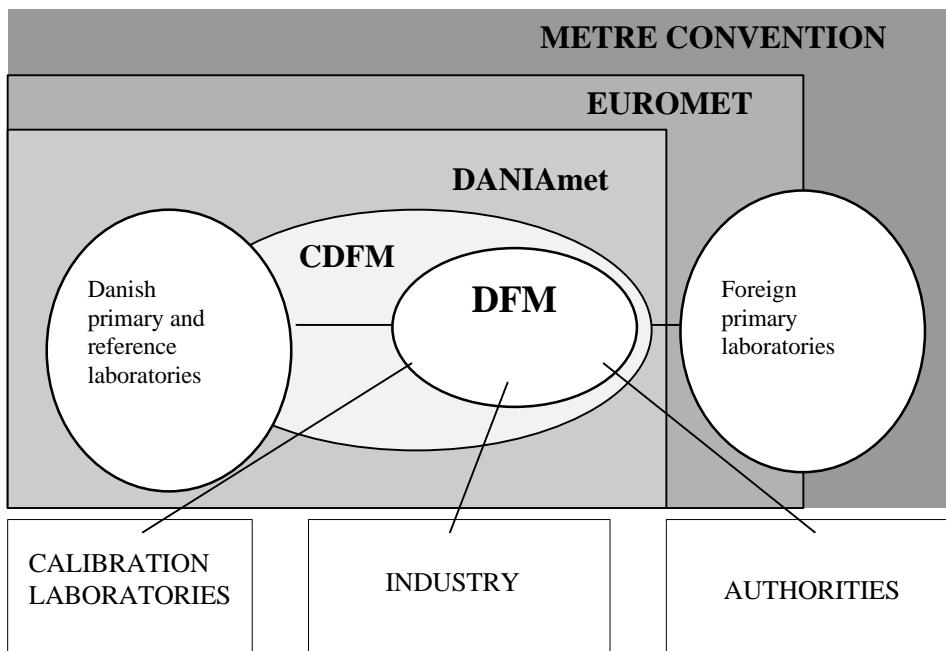
2.5 Marketing



*During 1999 DFM
has expanded its
marketing activities*

An effort has been made to improve marketing of DFM products. A marketing agency has assisted in advertising in Denmark as well as abroad, and a total of 6 press releases have been issued, leading to 55 press citations. A small handbook entitled "Metrologi kort og godt" (Metrology in brief) has been particularly well received after a distribution of some 2500 copies, and has brought knowledge about metrology to a wide audience. Also, an marketing of DFMs uncertainty software tool "DFM-GUM" led to the sale of 35 copies of this software product, including several multi-user versions.

3. Metrology in Denmark



Structure of Danish metrology

Denmark has a decentralised metrology organisation, with DFM as the core institute. Closely associated with DFM are three research and technology organisations (*GTS Institutes*) with reference laboratories among their activities. Together with DFM they constitute the *Centre for Danish Fundamental Metrology (CDFM)*. The umbrella organisation *DANIAmet* covers all of the Danish primary and reference laboratories, some of which are within industrial companies.

Collaboration with primary laboratories outside of Denmark is carried out through the European umbrella organisation for national metrology institutes *EUROMET*, as well as on a bilateral basis, and the global background is provided by the *Metre Convention* which was signed by Denmark when it was established in 1875.

At the technical level, metrology is divided into 10 subject fields, which have in Denmark been further subdivided into 36 subfields. For each subfield, the Danish Agency for Development of Trade and Industry may nominate a primary laboratory or a national reference laboratory according to the following definitions:

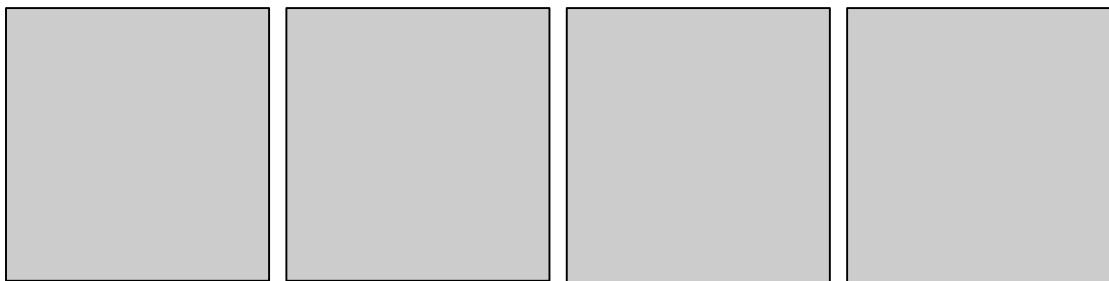
Primary laboratory:

A nominated laboratory, which is internationally recognised for the realisation of a base unit of the SI system at the primary level, or a derived unit at the highest achievable international level, and which carries out internationally recognised research within the sub-field.

National reference laboratory:

A nominated laboratory, which is capable of calibrating a given measurement quantity at the highest level of accuracy in Denmark, traceable to a foreign primary laboratory

**GOVERNING
BOARD**



3.1 Danish Institute of Fundamental Metrology - DFM

The organogram of DFM is shown in the figure above. The Board of Governors is appointed by Danish Industry (2), the Technical University of Denmark (1), the GTS Institutes (2), DANIAmet (1), and the staff of DFM (2). The board in turn appoints a director as responsible for the daily management. According to DFM's statutes of August 20, 1997, in addition to governing DFM, the board is responsible for coordinating fundamental metrology in Denmark.

Board of Governors

Knut Conradsen, Vice President, Technical University of Denmark (Vice Chairman)

Kim A. Hueg, M.Sc., (Chairman until 20 August)

Peter Huntley, Head of Department, Dansk Industri, (Vice Chairman until 20 August)

Hans Dalsgaard Jensen, Staff Scientist, Ph.D., DFM

Ole Bjørn Jensen, Managing Director, SCANPHARM A/S (from 20 August)

Steen Konradsen, Managing Director, AREPA Test & Calibrering A/S (Chairman)

Lars Ole Kornum, President, Danish Technological Institute

Lars Nielsen, Staff Scientist, Ph.D., DFM

Hans Jørgen Pedersen, Vice President DANFOSS A/S (from 20 August)

Knud Rimmer, Managing Director, FORCE Institute

Management

Kim Carneiro, M.Sc. (EE), Ph.D.

Accountant

Juul & Partnere, Certified Accountant

Permanent Staff

Kim Carneiro, M.Sc. (EE), Ph.D.
Grethe Bjørndal Jensen, Secretary.
Lars Nielsen, M.Sc. (EE), Ph.D.
Steen Rahbek, Technician.
Hans Dalsgaard Jensen, M.Sc. (EE), Ph.D.
Jan Conrad Petersen, M.Sc., Ph.D.
Jes Henningsen, Ph.D., Dr.scient.
Jørgen Garnæs, M.Sc., Ph.D.
Harald R. Simonsen, M.Sc., Ph.D.
Merethe Kjøller Jensen, Secretary.
Karsten Simonsen, B.Sc. (EE)
Bendt Gerhardt, M.Sc. (Commerce)
Peter Høgh Hyllested, Technician
Carl Erik Torp, M.Sc.
Preben Howarth, M.Sc. (ME), B.Sc. (Economy)
Trine E. Møgelberg, M.Sc., Ph.D.(until July 31)
Eva Trudsø, M.Sc. (Chemistry), (until March 31)
Michael Pustilnik, Ph.D. (post doc)
Rafael J. Taboryski, Ph.D. (from February 1)
Anders Kühle, Ph.D. (from February 1)

Non-permanent Staff, including research students

Daniel Greve, Ph.D. student, University of Copenhagen
Jeanett Norrbohm Sørensen, Ph.D. student, Technical University of Denmark
Kai Dirscherl, Diplomingeniør, Ph.D. student, Technical University of Denmark
Kim Schüsler, M.Sc. (EE), Head of Calibrations, Tellabs A/S
Guisepppe Basile, Professor, Istituto di Metrologia “G. Colonnetti”, Torino, Italy
Kim A. Hueg, M.Sc.(EE)
Marie Wandel, Master student CISMI
Ulla Lätheenmäki, Director, Professor, Centre Metrology and Accreditation, Helsinki, Finland
Wolfgang Richter, Director, Professor, Physikalisch-Technische Bundesanstalt, Braunschweig, Germany
José A. P. Conde Vo, M.Sc., Danish Technological Institute
Sune Vang, Student, Niels Bohr Institute, University of Copenhagen
Niels Kofod, Ph.D.student, Technical University of Denmark
Uffe S. Mikkelsen , Levnedsmiddekontrollen i Sønderjylland
Fabrice Rose, Student, France
Connie Nielsen, Master student, Technical University of Denmark

3.2 Centre of Danish Fundamental Metrology - CDFM

Centre of Danish Fundamental Metrology (CDFM) was founded in August 1997, and includes those GTS institutes, who are active in fundamental metrology. At present CDFM includes Danish Institute of Fundamental Metrology, Danish Technological Institute, FORCE Institute, and DELTA Danish Electronics, Light & Acoustics.

3.3 DANIAmet

DANIAmet is an umbrella organisation for laboratories which are nominated by the Danish Agency for Development of Trade and Industry as Primary or National Reference Laboratories. The task of this organisation is to further the common interests of the members within the field of fundamental metrology, to seek or suggest representation in relevant councils and bodies, to work for strengthening fundamental metrology in Denmark, to represent Danish fundamental metrology abroad, and to disseminate information

about metrology. The members ordinarily meet twice each year. The President of DANIAmet is Sven Nytoft Rasmussen, Danish Technological Institute, and DFM acts as permanent secretariat. DANIAmet at present includes:

DFM

Subfield: Mass measurement (Primary Laboratory).
 Contact person: Lars Nielsen, DFM, Anker Engelunds Vej 1, DK 2800 Lyngby.
 Telephone: +45 4525 5866. Telefax: +45 4593 1137

DFM

Subfield: Length measurement (Primary Laboratory).
 Contact person: Jes Henningsen, DFM, Anker Engelunds Vej 1, DK 2800 Lyngby.
 Telephone: +45 4525 5865. Telefax: +45 4593 1137

DFM

Subfield: DC electricity (Primary Laboratory).
 Contact person: Hans Dalsgaard Jensen, DFM, Anker Engelunds Vej 1, DK 2800 Lyngby.
 Telephone: +45 4525 5874. Telefax: +45 4593 1137

DFM

Subfield: Optical radiometry (Primary Laboratory).
 Contact person: Jan C. Petersen, DFM, Anker Engelunds Vej 1, DK 2800 Lyngby.
 Telephone: +45 4525 5864. Telefax: +45 4593 1137

Danish Primary Laboratory for Acoustics

Subfields: Acoustical measurements in gases and solids (Primary Laboratory)
 Contact persons: Erling Frederiksen (Microphones) and Torben R. Licht (Accelerometry), Brüel and Kjær A/S, Skodsborgvej 307, DK 2850 Nærum
 Telephone: +45 4580 0500, Telefax: +45 7741 2013.
 Knud Rasmussen, Institute of Acoustical Technology, Building 352, Technical University of Denmark, DK 2800 Lyngby.
 Telephone: +45 4525 3937. Telefax: +45 4588 0577.

Radiometer Medical A/S

Subfield: pH measurement (Primary Laboratory).
 Contact person: Hans Bjarne Kristensen, Åkandevej 21, DK 2700 Brønshøj.
 Telephone: +45 3827 3827. Telefax: +45 3827 2727

AREPA Test & Calibration A/S

Subfield: AC electricity (Reference Laboratory)
 Contact person: Torsten Lippert, Mads Clausens Vej 12, DK 8600 Silkeborg.
 Telephone: +45 8720 6969. Telefax: +45 8681 2654.

Danish Technological Institute

Subfield: Temperature measurement by contact (Reference Laboratory).
 Contact person: Jan-Ulrik Holtoug, Teknologiparken, DK 8000 Aarhus C.
 Telephone: +45 8943 8943. Telefax: +45 8943 8543.

FORCE Institut

Subfield: Force and Pressure (Reference Laboratory)

Contact person: Lene Schou Sørensen, Park Allé 345, DK 2605 Brøndby.
 Telephone: +45 4326 7000. Telefax: +45 4326 7011.

FORCE Institute

Subfield: Gas volume flow (Reference Laboratory)
 Contact person: Jesper Busk, Navervej 1, DK 6600 Vejen.
 Telephone: +45 7696 1600. Telefax: +45 7536 4155.

National Laboratory for Geometrical Metrology (NGM)

Subfield: Dimensional metrology (Primary Laboratory)
 Contact person: Leonardo De Chiffre, NGM-CGM, Building 425, Technical University of Denmark,
 DK 2800 Lyngby.
 Telephone: +45 4525 4760, Telefax: +45 4593 0190
 Sven Nytoft Rasmussen, Danish Technological Institute, DK 2630 Taastrup .
 Telephone: +45 4350 4442. Telefax: +45 4350 7273

Danish Technological Institute

Subfield: Flow of water (Reference Laboratory)
 Contact person: Michael Thrane, Teknologiparken, DK 8000 Aarhus C.
 Telephone: +45 8943 8943. Telefax: +45 8943 8543.

Agilent Technologies A/S

Subfield: HF electricity (Reference Laboratory)
 Contact person: Kurt Jensen, Kongevejen 25, DK 3460 Birkerød.
 Telephone: +45 4599 1275. Telefax: +45 4599 1001.

FORCE Institute

Subfield: Volumen and density (Reference Laboratory)
 Contact person: Lene S. Kristensen, Park Alle 345, DK 2605 Brøndby.
 Telephone: +45 4326 7000. Telefax: +45 4326 7011.

DELTA Danish Electronics, Light & Acoustics

Subfield: Humidity (Reference Laboratory)
 Contact person: Povl Knud Birch, Venlighedsvej 4, DK 2970 Hørsholm.
 Telephone: +45 4586 7722. Telefax: +45 4586 5898.

3.4 Reference Laboratories outside of DANIAmet

Danish Ministeries and Agencies other than the Agency for Development of Trade and Industry have nominated Reference Laboratories for specialised subfields. Subfields are given in accordance with Section 3.5. Some laboratories within the subject field of chemistry have responsibilities which do not strictly follow this grouping.

National Institute of Occupational Health

Subfield: Environmental Chemistry
 Contact person: Jytte Molin Christensen, Lersø Parkallé 105, DK 2100 København Ø
 Telephone: +45 3916 5200. Telefax: +45 3916 5201.
 Ministry: Ministry of Environment and Energy

Subfield: Environmental Chemistry (measurement of emission in air)
 Contact person: Kasper Rovsing Olsen, Gladsaxe Møllevej 15, DK 2860 Søborg
 Telephone: +45 3955 5999. Telefax: +45 3969 6002.
 Ministry: Ministry of Environment and Energy

DHI Water & Environment

Subfield: Environmental Chemistry (water)
 Contact person: Kirsten Andersen, Agern Allé 11, 2970 Hørsholm
 Telephone: +45 4516 9200. Telefax: +45 4516 9292.
 Ministry: Ministry of Environment and Energy

Miljø- og Levnedsmiddelkontrollen MLK Fyn I/S

Subfield: Microbiology
 Contact person: Flemming Boisen, Lille Tornbjerg Vej 24, 5220 Odense SØ
 Telephone: +45 6556 5600. Telefax: +45 6556 5699.
 Ministry: Ministry of Environment and Energy

Danmarks Jordbruksforskning

Subfield: Food Chemistry/Environmental Chemistry
 Contact person: Ole Permin, Forsøgsvej 1, Flakkebjerg, 4200 Slagelse
 Telephone: +45 5811 3300. Telefax: +45 5811 3301.
 Ministry: Ministry of Food, Agriculture, and Fishing

Danmarks Jordbruksforskning

Subfield: Food Chemistry (agriculture)
 Contact person: Arent Josephsen, Forskningscenter Foulum, Box 50, DK 8830 Tjele
 Telephone: +45 8999 1680. Telefax: +45 8999 1919.
 Ministry: Ministry of Food, Agriculture, and Fishing

Institut for Fødevareundersøgelser og Ernæring

Subfield: Food Chemistry
 Contact person: Tine Falkner Mathiassen, Mørkhøj Bygade 19, DK 2860 Søborg
 Telephone: +45 3395 6410. Telefax: +45 3395 6619.
 Ministry: Ministry of Food, Agriculture, and Fishing

Plantedirektoratet

Subfield: Food Chemistry
 Contact person: Niels Ellermann, Skovbrynet 20, DK 2800 Lyngby
 Telephone: +45 4596 6620. Telefax: +45 4596 6610.
 Ministry: Ministry of Food, Agriculture, and Fishing

Statens Institut for Strålehygiejne

Subfield: Ionising radiation and radioactivity
 Contact person: Klaus Ennow, Knapholmen 7, DK 2730 Herlev
 Telephone: +45 4454 3454. Telefax: +45 4454 3450.
 Ministry: Ministry of Health

Statens Serum Institut

Subfield: Microbiology
 Contact person: Mia Flinta, Artillerivej 5, DK 2300 København S

Ministry: Telephone: +45 3267 8103. Telefax: +45 3268 3868.
Ministry of Health, Ministry of Food, Agriculture and Fishing

Retsmedicinsk Institut

Subfield: Clinical Chemistry
Contact person: Thomas Helboe, Frederik den Vs Vej 11, DK 2100 Copenhagen Ø
Telephone: +45 3532 6229. Telefax +45 3532 6085.
Ministry: Ministry of Law

Lægemiddelstyrelsen

Subfield: Microbiology
Contact person: Margit Handlos, Frederikssundsvej 378, DK 2700 Brønshøj
Telephone: +45 4488 9287. Telefax: +45 4488 9228.
Ministry: Ministry of Health

Plantedirektoratet

Subfield: Food Chemistry, Biochemistry, Microbiology
Contact person: Henning Hecht, Skovbrynet 20, DK 2800 Lyngby
Telephone: +45 4596 6603. Telefax: +45 4596 6610
Ministry: Ministry of Food, Agriculture and Fishing

National Environmental Research Institute

Subfield: Environmental Chemistry
Contact person: Bente Nyeland, DMU, Frederiksborgvej 399, DK 4000, Roskilde
Telephone: +45 4630 1200. Telefax: +45 4630 1114.
Ministry: Ministry of Environment

Frederiksberg Hospital

Subfield: Clinical Chemistry
Contact person: Rene Dybkjær, Nordre Fasanvej 57, DK-2000 Frederiksberg
Telephone: +45 3816 3870. Telefax: +45 3816 3879.
Ministry: Ministry of Health

Fødevaredirektoratet

Subfield: Food Chemistry
Contact person: Inge Meyland, Mørkhøj Bygade 19, DK 2860 Søborg
Telephone: +45 3395 6404. Telefax: +45 3395 6619.
Ministry: Ministry of Food, Agriculture and Fishing

Københavns Amts Sygehus, Herlev

Subfield: Clinical Chemistry
Contact person: Adam Uldall, Herlev Ringvej 75, DK 2730 Herlev,
Telephone: +45 4488 3310. Telefax: +45 4488 4489.
Ministry: Ministry of Health

3.5 The 10 subject fields of metrology

Fundamental metrology is divided in accordance with the ten EUROMET fields, mass, electricity, length, time and frequency, thermometry, ionising radiation & radioactivity, photometry and radiometry, flow, acoustics and amount of substance. Plans of action for each field are published and serve as guide lines in the nomination of primary and reference laboratories. The years in which plans of action are published are shown in parenthesis.

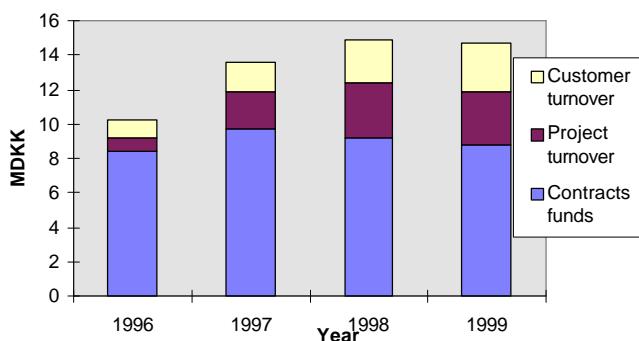
SUBJECT FIELD	SUBFIELD	LABORATORY
MASS (1989, 1997)	Mass measurement	Danish Institute of Fundamental Metrol- ogy. <i>Primary Laboratory</i>
	Force and Pressure	FORCE Institute. <i>Reference Laboratory</i>
	Volume and Density	FORCE Institute. <i>Reference Laboratory</i>
ELECTRICITY (1989, 1994)	DC electricity	Danish Institute of Fundamental Metrol- ogy. <i>Primary Laboratory</i>
	AC electricity	AREPA Test & Calibration A/S. <i>Refer- ence Laboratory</i>
	HF electricity	Agilent Technologies A/S. <i>Reference Laboratory</i>
	High current and high voltage	
LENGTH (1989, 1998)	Length measurements	Danish Institute of Fundamental Metrol- ogy. <i>Primary Laboratory</i>
	Dimensional metrology	Nationalt Reference Laboratory for Geo- metrical Metrology (NGM). <i>Reference Laboratory</i>
TIME AND FREQUENCY (1992)	Time measurement	
	Frequency	
THERMOMETRY (1992, 1999)	Temperature measurement by contact	Danish Technological Institute. <i>Reference Laboratory.</i>
	Non-contact temperature meas- urement	
	Humidity	DELTA Danish Electronics, Light & Acoustics. <i>Reference Laboratory</i>

SUBJECT FIELD	SUBFIELD	LABORATORY
IONISING RADIATIONS AND RADIOACTIVITY (1992)	Absorbed radiation dose Industrial products.	
	Absorbed radiation dose Medical products	
	Radiation protection	
	Radioactivity	
PHOTOMETRY AND RADIOMETRY (1990, 1996)	Optical Radiometry	Danish Institute of Fundamental Metrol- ogy. <i>Primary Laboratory</i>
	Photometry	
	Colorimetry	
	Optical fibres	
FLOW (1990, 1999)	Gas flow (volume)	FORCE Institute. <i>Reference Laboratory</i> .
	Flow of water (volume, mass and energy)	Danish Technological Institute. <i>Reference Laboratory</i> .
	Flow of liquids other than water	FORCE Institute. <i>Reference laboratory</i> .
	Anemometry	
ACOUSTICS (1992)	Acoustical measurements in gases	Danish Primary Laboratory for Acoustics, Brüel & Kjær A/S. <i>Primary Laboratory</i>
	Acoustical measurements in solids	
	Acoustical measurements in liquids	
AMOUNT OF SUBSTANCE (1992, 1995)	Environmental chemistry	
	Clinical chemistry	
	Materials chemistry	
	Food chemistry	
	Biochemistry	
	Microbiology	
	pH measurement	Radiometer Medical A/S. <i>Primary Laboratory</i> .

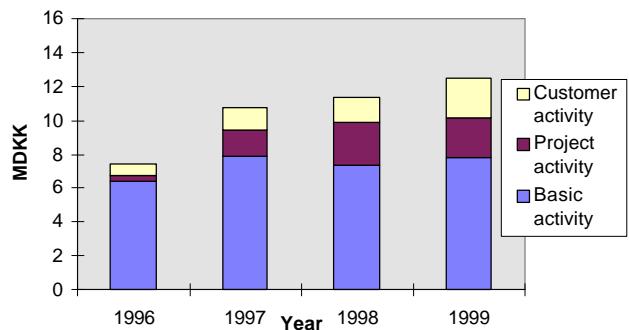
4. Key Figures

Economy (million Danish kroner)	1996	1997	1998	1999
Turnover gross	10.2	13.6	14.8	14.7
Turnover net	7.5	10.7	11.4	12.5
Result for the year	-2.8	-0.4	-0.4	-1.3
Outlay (per gross turnover)	27%	21%	23%	15%
Equity	12.6	12.2	10.6	8.4
R & D - external financed	5.5	7.5	7.0	8.1
R & D - internally financed	2.0	1.3	2.4	3.6
R & D Total	7.5	8.8	9.4	11.7
Export turnover from projects and customers	0.6	1.7	2.3	3.5
Danish turnover from projects and customers	1.2	2.2	3.3	2.5
Contract funds from Government	8.4	9.7	9.2	8.7
Gross turnover	10.2	13.6	14.8	14.7
Permanent staff - professional training				
Scientific	9	10	13	13
Other academic	1	2	2	3
Other technical	3	3	3	3
Administrative	2	2	2	2
Total	15	17	20	21
Calibration certificates	31	32	31	49
Publications	11	15	14	21
Conference contributions	27	29	22	29
Teaching (participants)	-	-	185	200

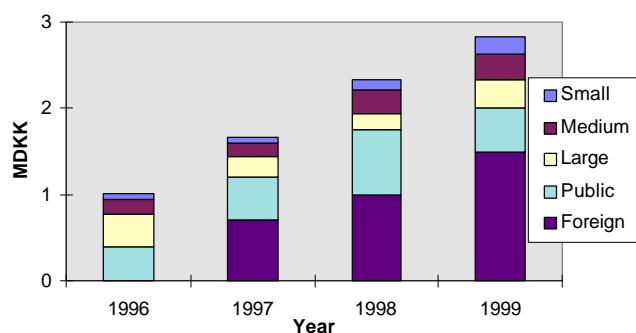
Gross turnover according to type of contract



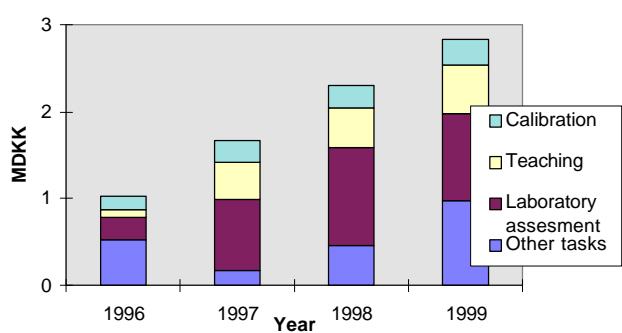
Net turnover according to type of activity



Customer turnover according to type of customer



Customer turnover according to type of service



5. Accounts of Particular Activities

Refereed publications in international journals and monographs

J. Henningsen, H. Simonsen, T. Møgelberg, E. Trudsø, "The 0-3 Overtone Band of CO: Precise Line-strengths and Broadening Parameters", *J. Mol. Spectrosc.* 193, 354-362 (1999), DFM-99-P1

S. Krüger Olsen, A. Kühle, C. Træholt, C. Rasmussen, O. Tønnesen, M. Däumling, C. N. Rasmussen, D. W. A. Willén, "Alternating current losses of a 10 metre long low loss superconducting cable conductor determined from phase sensitive measurements", *Supercond. Sci. Technol.* 12, 360-365 (1999), DFM-99-P2

D. Greve, T. Geisler, J. C. Petersen, T. Bjørnholm, "Molecules with multi-directional charge-transfer (MDCT) transitions as promising chromophores for third nonlinear optics", *Synthetic Metals* 102, 1533-1534 (1999), DFM-99-P5

Hans D. Jensen and Jeanett Sørensen, "Electrolytic conductivity at DFM - results and experiences", Proceedings of the 146. PTB Seminar, Braunschweig Germany, 4-5. February 1999, DFM-99-P6

Hans D. Jensen and Jeanett Sørensen, "An accredited facility for measurement of electrolytic conductivity - a European first", Proceedings of the 21st Nordic Conference on Measurements and Calibration, Gardermoen, Norway, 22-23. November 1999, DFM-99-P7

R.Taboryski, J.Kutchinsky, J.Bindslev Hansen, M.Wildt, C.B.Sørensen, and P.E.Lindelof, "Multiple Andreev reflections in diffusive SNS structures", *Superlattices and Microstructures* 25, 829 (1999), DFM-99-P8

J.Kutchinsky, R.Taboryski, C.B.Sørensen, J.Bindslev Hansen, and P.E.Lindelof "Observation of supercurrent enhancement in SNS junctions by non-equilibrium injection into supercurrent carrying bound Andreev states", *Phys.Rev.Lett.* 83, 4856 (1999), DFM-99-P9

J.Bindslev Hansen, J.Kutchinsky, R.Taboryski, O.Kuhn, S.B.Sørensen, P.E.Lindelof, C.Schelde Jacobsen, A.Kristensen, and J.L.Skov, "Coherent transport in the diffusive regime in mesoscopic superconductor semiconductor (S/Sm/S) junctions of Al/n++ GaAs/Al", in *Mesoscopic Josephson Junctions*, edited by H.Ohta and C.Ishii, The Physical Society of Japan (1999), DFM-99-P10

K. Flensberg, A.A. Odintsov, F. Liefrink and R. Teunissen, "Towards single-electron metrology", *International Journal of Modern Physics B* 13, 2651-2687 (1999), DFM-99-P11

N.A. Mortensen, K. Flensberg and A.-P. Jauho, "Angle dependence of Andreev scattering at semiconductor-superconductor interfaces", *Physical Review B* 59, 10176-10182 (1999), DFM-99-P12

J.Kutchinsky, R.Taboryski, J.Bindslev Hansen, Morten Wildt, C.B.Sørensen, and P.E.Lindelof, "Bias voltage dependence of a flux-sensitive Al/GaAs/Al (SNS) interferometer" *IEEE Trans. Appl. Superconductivity* 9, 4249 (1999).

J.Kutchinsky, M.Wildt, R.Taboryski, O.Kuhn, C.B.Sørensen, J.B.Hansen, P.E.Lindelof "Strong non-equilibrium coherent states in mesoscopic superconductor-semiconductor-superconductor junctions" *J.Supercond.* 12, 839 (1999).

C. Træholt C, A. Kühle, S.K. Olsen, O. Tønnesen, "The electrical aspects of the choice of former in a high Tc superconducting power cable", *IEEE Trans. Appl. Supercond.* 9, 766-769 (1999).

S. K. Olsen, C. Træholt, A. Kühle, O. Tønnesen, M. Däumling, J. Østergaard, "Loss and inductance investigations in a 4-layer superconducting prototype cable conductor", *IEEE Trans. Appl. Supercond.* 9, 833-836 (1999).

- A. Kühle, C. Træholt, S. K. Olsen, C. Rasmussen, O. Tønnesen, M. Däumling, "Measuring AC-loss in high temperature superconducting cable-conductors using four probe methods", IEEE Trans. Appl. Supercond. 9, 1169-1172 (1999).
- C. Rasmussen, A. Kühle, O. Tønnesen, O., C. N. Rasmussen, "Design of a termination for a high temperature superconducting power cable", IEEE Trans. Appl. Supercond. 9, 1273-1276 (1999).
- F. Sahlén, T. Geisler, S. Hvilsted, N.R.C. Holme, P.S. Ramanujam, and J.C. Petersen, "Combined Main- and Side-chain Azobenzene Polyesters: A Potential for Photoinduced Nonlinear Waveguides", Mat. Res. Soc. Symp. Proc. Vol. 561, (1999), pp. 57-62.
- P. Nordlander, M. Pustilnik, Y. Meir, N. Wingreen, and D. Langreth, "How long does it take for the Kondo effect to develop ?" Phys. Rev. Lett. 83, 808 (1999).
- Deng Guoyang and Jes Henningsen, "Quantitative Measurement of Adsorption of CH₃OH on Commonly Used Materials by Photoacoustic Method", Acta Physico-Chimica Sinica 15, 764-768 (1999).
- J. Garnaes, N. Kofod, J. F. Jørgensen, A. Kühle, P. Besmens, O. Ohlsson, J. B. Rasmussen, P. E. Lindelof, G. Wilkening, L. Koenders, W. Mirande, K. Hasche, J. Haycocks, J. Nunn, M. Stedman, "Nanometre scale transfer standards", Proceedings for euspen 1st international conference and general meeting of the european society for precision engineering and nanotechnology, Edited by: P. McKeown, J. Corbett et al., on May 31st - June 4th 1999 Congress Centre Bremen, Germany, Vol 2, 134-137 (1999)
- K. Flensberg, Q. Niu, and M. Pustilnik, "Non-adiabaticity and single-electron transport driven by surface acoustical waves", Physical Review B 60, R16291 (1999).

Dissertations

Ane Jensen, "Ferromagnet/halvlederkontakter" (in Danish), MSc Thesis, Technical University of Denmark, Institute of Physics, March 1999. Advisors: Steen Mørup, Rafael Taboryski, Jørn Bindslev Hansen.

Other publications and reports (1999)

- J. Henningsen, Bendt Gerhardt og Kim Carneiro, "DFM årsrapport 1998", DFM-99-R1
- A. Zarka, H. Simonsen, A. Abou-Zeid, "Report on the first meeting on the group on Laser Diode Heads 17-18 April 1997", DFM-99-R2
- E. Trudsø, Trine E. Møgelberg, og Jan. C. Petersen, "Kemisk metrologi - DFMs rolle fremover", DFM-99-R3
- J. Garnæs, "Forundersøgelser af kvældning med atomic force microscope", DFM-99-R4
- K. Carneiro, H. Simonsen, S. Carpenter, N. Pugh, L. Erard, R. Kaarls, H. Kunzmann, T. Quinn, M. Vidi gal, A. Wallard, "Equivalence of calibration certificates between NIST and European NMI's", DFM-99-R5
- J. Henningsen, "Monitering med diodelaser og fouriertransform spektroskopi", DOPS-NYT 2-1999, 19-24, DFM-99-R6
- J. Garnæs, N. Kofod, J. F. Jørgensen, A. Kühle, P. Besmens, O. Ohlsson, J. B. Rasmussen, G. Wilkening, L. Koenders, W. Mirande, K. Hasche, J. Haycocks, J. Nunn, M. Stedman, "Standards for Scanning Probe Microscopes", Preliminary Proceedings of STM'99 10th International Conference on Scanning Tunneling Microscopy/Spectroscopy and Related Technique, Edited by: Y. Kuk, I. W. Lyo, D. Jeon, S.-I. Park, Seul, Korea, July 19-23,

DFM-99-R7

J. Garnæs, N. Kofod, J. F. Jørgensen, A. Kühle, P. Besmens, O. Ohlsson, J. B. Rasmussen, P. E. Lindelof, G. Wilkening, L. Koenders, W. Mirande, K. Hasche, J. Haycocks, J. Nunn, M. Stedman, "Nanometre scale transfer standards", DFM-99-R8

J. W. Thomsen, H. Simonsen, "Ultrapræcise ure med kolde atomer", DOPS-NYT 2-1999, 11-14, DFM-99-R9

H. Simonsen, "Realisering af meteren ved frekvensstabile lasere", DOPS-NYT 2-1999, 6-11 DFM-99-R10

J. C. Petersen, "Optisk radiometri", DOPS-NYT 2-1999, 30-34, DFM-99-R11

J. C. Petersen, "Molekyler som bølgelængdenormaler", DOPS-NYT 2-1999, 24-26, DFM-99-R12

F. Sahlén, T. Geisler, S. Hvilsted, N. C. R. Holme, P. S. Ramanujam, J. C. Petersen, "Combined and side-chain azobenzene polyesters: A potential for photoinduced nonlinear waveguides", DFM-99-R13

K. Carneiro, "Faglig rapportering til Rådet for Teknologisk Service 1998", DFM-99-R14

P. Howarth, "Manual for Interlaboratory Comparisons and Calibrations", DFM-99-R15

B. King, M. Walsh, K. Carneiro, R. Kaarls, V. Kompa, C. Nieto De Castro, J. Lexow, "Metrology in Chemistry - Current Activities and Future requirements in Europe", DFM-99-R16

J. Henningsen, "Præstationsprøvning DANAK M4", DFM-99-R17. Confidential.

H. D. Jensen, "Status report for SMT4-CT97-2159", DFM-99-R18

P. Howarth, "CDFM demo-projekt Flow", DFM-99-R19

Lars Nielsen, "Måleusikkerhed ved kalibrering af vægte", DFM-99-R20. Confidential.

Lars Nielsen, "Primary Laboratory for Mass Annual Report 1998", DFM-99-R21

H. Blichfeldt, "Måleusikkerhed af lodders masse, volumenbestemmelse", DFM-99-R22

P. Howarth, "CDFM demo-projekt Joint Strike Fighter", DFM-99-R23

P. Howarth, "CDFM demo-projekt temperatur og fugt", DFM-99-R24

J. Henningsen, "NIF Præstationsprøvning, Passbiter - centerlængde", DFM-99-R25. Confidential.

J. Henningsen, "NIF Præstationsprøvning, Passbiter - centerlængde", DFM-99-R26. Confidential.

K. Carneiro, "Strategiplan 2000-2002", DFM-99-R27.

H. D. Jensen, "Minutes of EUROMET AC/DC Transfer Experts meeting", DFM-99-R28.

J. Kutchinsky, R. Taboryski, C. B. Sørensen, J. B. Hansen, P. E. Lindelof, "Enhancement of superconducting critical current by injection of quasiparticles in superconductor semiconductor devices", DFM-99-R30.

M. Wildt, J. Kutchinsky, R. Taboryski, C. B. Sørensen, J. B. Hansen, P. E. Lindelof, "Photon Assisted Andreev Transport and Sub-Gap Structures", DFM-99-R31.

J. C. Petersen, "Reference Laboratory for Optical Radiometry Annual Report 1998", DFM-99-R33

J. Henningsen, "Primary Laboratory for Length. Annual Report 1998", DFM-99-R34

J. Henningsen, "NIF Præstationsprøvning. Måleklodser - centerlængde", DFM-99-R35

H. D. Jensen, "Primary laboratory for DC Electricity, Annual Report 1998", DFM-99-R36

A. Kühle, "COMF: Image Metrology rapport nr. 1", DFM-99-R37. Confidential.

Jes Henningsen - "Fire & Gas. Progress Report No. 5", DFM-99-R38. Confidential.

Lars Nielsen, "Evaluation of measurement intercomparison by the methos of least squares", DFM-99-R39

Contributions at conferences

A. Kühle, "Standards for Scanning Probe Microscopes", 10th International Conference on Scanning Tunneling Microscopy / Spectroscopy and Related Proximal Probe Microscopy - STM99, Seoul July 19-23, 1999, (oral).

J.Kutchinsky, R.Taboryski, C.B.Sørensen, J.Bindslev Hansen, and P.E.Lindelof "Enhancement of superconducting critical current by injection of quasiparticles in superconductor semiconductor devices", Proceedings of the 22'st International Conference on Low Temperature Physics (LT22), Helsinki, Finland, August 1999, (poster).

Henrik Blichfeldt, "Laboratory glassware for the measurement of volume and density". Measurement & Quality 99, Odense, Denmark, 1999. (In danish).

Henrik Blichfeldt, "Volume determination of weights at DFM", 21. Nordic Conference on Metrology and Calibration, Gardermoen, Norway, 1999.

H. Simonsen, J. Henningsen, and J. Engholm, "Tunable Er³⁺-doped fiber laser at 1578 nm as wavelength standard", Danish Optical Society Annual Meeting, 18-19 november, 1999.

Jes Henningsen and Harald Simonsen, "Detection of CO₂, CO, and H₂S with a DFB laser at 1.57 μm", Danish Physical Society Annual Meeting 1999, Nyborg Strand, 3.-4. June, 1999

J. Henningsen and H. Simonsen, "Open air detection of CO₂, CO, and H₂S with a DFB laser at 1.57 μm", Advanced Semiconductor Laser Applications, ASLA '99, Sta. Barbara, USA 21-23. July 1999.

J. Henningsen and H. Simonsen, "Quantitative wavelength modulation spectroscopy without calibration gas", Advanced Semiconductor Laser Applications, ASLA '99, Sta. Barbara, USA 21-23. July 1999

F. Sahlén, T. Geisler, S. Hvilsted, N.R.C. Holme, P.S. Ramanujam, and J.C. Petersen, "Combined Main-and Side-Chain Azobenzene Polyesters: A Potential for Photoinduced Nonlinear Waveguides", Materials Research Society, Spring Meeting 1999, San Francisco, April 5-9, 1999. Paper F3.6.

Kim Carneiro, "Transfer standards for SPM", CIRP STC-"S", Paris, 1. January.

Kim Carneiro, "Equivalence of Calibration Certificates between NIST and European NMIs", NCSL conference and workshop, Charlotte NC, 1999, 10-15 July.

Kim Carneiro: "The Importance Of International Collaboration For National Metrology Infrastructures" Slovenian Metrology Day, 13. May, 1999.

Kim Carneiro: "The Status of Traceability in Chemical Measurement". EURACHEM's workshop, Bratislava, 6-8 September, 1999

Kim Carneiro: "Innovation and Metrology", PEFIM conference on industrial metrology and strategic planning, 2-4 November, 1999.

Lars Nielsen, "Evaluation of measurement intercomparisons by the method of least squares", Workshop on Statistical Analysis of Interlaboratory Comparisons, 11-12 november 1999, NPL, Teddington, UK.

J. Garnaes, N. Kofod, J. F. Jørgensen, A. Kühle, P. Besmens, O. Ohlsson, J. B. Rasmussen, P. E. Lindelof, G. Wilkening, L. Koenders, W. Mirande, K. Hasche, J Haycocks, J. Nunn, M. Stedman, "Nanometre scale transfer standards", euspen 1st International Conference and General Meeting of the European Society for Precision Engineering and Nanotechnology, Congress Centre Bremen, Germany, May 31 - June 4, 1999 (oral)

J. Garnaes, N. Kofod, J. F. Jørgensen, A. Kühle, P. Besmens, O. Ohlsson, J. B. Rasmussen, P. E. Lindelof, G. Wilkening, L. Koenders, W. Mirande, K. Hasche, J Haycocks, J. Nunn, M. Stedman, "Standards for

Scanning Probe Microscopes", 10th International Conference on Scanning Tunneling Microscopy/Spectroscopy and Related Technique, Seul, Korea, July 19-23, 1999 (oral)

K. Dirscherl, J. Garnaes, J. F. Jørgensen, L. Nielsen, M. P. Sørensen, "Modelling the hysteresis of the scanning probe microscope", 10th International Conference on Scanning Tunneling Microscopy/Spectroscopy and Related Technique, Seul, Korea, July 19-23, 1999 (oral).

K. Flensberg, Q. Niu, M. Pustilnik, "Theory of single electron transport through a one-dimensional channel driven by surface acoustic waves", Danish Physical Society Annual Meeting, 3-4 June, Nyborg.

M. Pustilnik, Y. Avishai and K. Kikoin, "Kondo effect in a finite magnetic field in quantum dots with even number of electrons", NATO Advanced Study Conference, 13.-25. June, Turkey.

K. Flensberg, Q. Niu and M. Pustilnik, "Single electron devices driven by surface acoustical waves", NATO Advanced Study Conference, 13.-25. June, Turkey.

Hans D. Jensen, "Electrolytic conductivity at DFM - results and experiences", 146. PTB Seminar, 4. februar, Braunschweig.

Hans D. Jensen and Jeanett Sørensen, "An accredited facility for measurement of electrolytic conductivity - a European first", 21st Nordic Conference on Measurements and Calibration, 23. november 1999, Gardermoen, Norge.

Trine Møgelberg, Eva Trudsø and Jes Henningsen, "Fourier and laser spectroscopy for quantitative detection of small gas concentrations", Danish Physical Society Annual Meeting, 3-4 June, Nyborg.

M. Pustilnik, "Kondo effect in magnetic field in quantum dots", 219th WEH Workshop on Interactions and Quantum Transport of Kower Dimensional Systems, Hamburg, Germany, 26.-28. July.

M. Pustilnik, "Cotunnelling through quantum dots with even number of electrons", Low Temperature Physcs LT22, Helsinki, Finland, 3.-11.August.

M. Wildt, J. Kutchinsky, R. Taboryski, C.B.Sørensen, J. Bindslev Hansen and P. E. Lindelof, "Photon assisted Andreev transport and sub-gap structures", Low Temperature Physics LT22, Helsinki, Finland, 3.-11. August.

R. Taboryski, J. Kutchinsky, C. B. Sørensen, J. Bindslev Hansen and P. E. Lindelof, "Supercurrent induced by injection at $V=\Delta/e$ in a three-terminal superconductor-semiconductor device", Electron Transport in Mesoscopic Systems, Gothenburg, Sweden, 12.-15. August.

J. Henningsen, "Precise Line Strengths and Broadening Parameters for the $2\nu_1+2\nu_2+\nu_3$ Combination Band of CO₂", 16th Colloquium on High Resolution Molecular Spectroscopy, Dijon, France, 6.-10. September.

Other talks

Anders Kühle, "Atomer - kan man se dem?", Roskilde Tekniske Skole, held at Institute of Physics, DTU, June 3rd 1999.

Hans D. Jensen, "DFM og den ultimative sporbarhed", contribution to DEKS user group meeting, Odense, September 9, 1999.

M. Pustilnik, "Single-electron transport driven by surface acoustic waves", Institute Colloquium, Niels Bohr Institute, 17. February.

Visitors

Francis Boillez, Cheval Frères SA, og Alain Lennquist, Friedman AB, design review meeting on new primary cell for conductivity

Kick-off meeting for EUROMET Project 515, May 10

Meeting concerning EU 5th Framework project, nanotechnology, March 25

Students from Struer Gymnasium, May 2

Kaj Nyholm and Jianpei Hu, Centre for Metrology and Accreditation (MIKES), International comparison of 543 nm He-Ne lasers, 6-10 December

6. Statement of Income 1999 (in Danish)

(14. regnskabsår)

6.1 Anvendt regnskabspraksis

Indtægter:

Indtægterne medtages i resultatopgørelsen i takt med arbejdets udførelse efter produktionskriteriet, hvilket medfører, at avancen på solgte ydelser medtages i resultatopgørelsen i takt med udførelsen af arbejdet, jævnfør nedenfor under igangværende arbejder.

Bevillinger forbrugt til udstyr, som regnskabsmæssigt afskrives, er indtægtsført i resultatopgørelsen.

Regnskabet er baseret på instituttets bogføring, men tallene er angivet i hele kroner (tusinde kroner for foregående år); Der kan derfor forekomme tilsvneladende afrundingsfejl ved sammentællingerne.

Materielle anlægsaktiver:

Småanskaffelser med en anskaffelsessum på under 20.000 kr. udgiftsføres i resultatopgørelsen.

Udstyr med begrænsede anvendelsesmuligheder, fremstillet af underleverandører, udgiftsføres.

Mindre kontorinventar udgiftsføres (tidligere blev dette afskrevet over 4 år; ændringen påvirker ikke årets resultat).

EDB-udstyr afskrives lineært over 3 år.

Videnskabeligt udstyr afskrives lineært over 4 år.

Igangværende arbejder:

Igangværende arbejder er optaget til salgsværdi omfattende medgået tid til salgspris med tillæg af afholdte udlæg.

6.2 Resultatopgørelse

Note	1999	1998 (1000 kr)
Kundeomsætning	2 830 301	2 437
Projektomsætning	3 111 786	3 204
Resultatkontrakt	8 740 000	9 200
BRUTTOINDTÆGTER I ALT	14 682 088	14 841
Underleverandører	1 219 287	1 799
Rejseomkostninger	901 854	814
Andre udlæg	110 945	1 358
UDLÆG I ALT	2 232 087	3 971
1 NETTOINDTÆGTER	12 450 001	10 870
2 Personaleomkostninger	9 157 792	8 066
Andre omkostninger	3 514 680	2 061
OMKOSTNINGER I ALT	12 672 472	10 127
RESULTAT AF ORDINÆR DRIFT	(222 471)	743
Afskrivninger	1 126 117	1 754
RESULTAT FØR RENTER	(1 348 589)	(1 011)
Nettorenter	76 407	641
ÅRETS RESULTAT	(1 272 182)	(371)

6.3 Balance pr. 1999-12-31

Note	AKTIVER	1999	1998 (1000 kr)
3	FINANSIELLE ANLÆGSAKTIVER	126 000	0
	Bygning under opførelse	226 920	0
4	Udstyr	1 258 391	1 632
	MATERIELLE ANLÆGSAKTIVER	1 485 311	1 632
	Igangværende arbejder	1 034 387	690
	Tilgodehavender	252 761	562
	Debitorer	909 903	868
	Periodeafgrænsninger	331 746	323
	TILGODEHAVENDER I ALT	2 528 796	2 443
5	LIKVIDE MIDLER I ALT	8 371 436	10 572
	OMSÆTNINGSAKTIVER I ALT	10 900 233	2 453
	AKTIVER I ALT	12 511 543	14 657

6.4 Direktionens underskrift

Lyngby, 2000-02-21

Kim Carneiro
Direktør

Note PASSIVER	1999	1998 (1000 kr)
Henlagt til nybyggeri	8 000 000	8 000
Overført resultat	1 395 982	2 668
EGENKAPITAL I ALT	9 395 982	10 668
Hensættelse	25 817	18
Forudbetalinger	703 747	1 341
Kreditorer og skyldige omkostninger	1 268 998	1 800
Feriepengeforpligtelse	1 117 000	830
KORTFRISTET GÆLD I ALT	3 089 744	3 971
PASSIVER I ALT	12 511 543	14 657

6.5 Bestyrelsens underskrifter

Lyngby, 2000-02-21

Knut Conradsen

Steen Konradsen

Hans Jørgen Pedersen

Formand

Lars Ole Kornum

Lars Nielsen
Medarbejderrepræsentant

Hans Dalsgaard Jensen
Medarbejderrepræsentant

Knud Rimmer

Ole Bjørn Jensen

6.6 Revisionspåtegning

Vi har revideret det af ledelsen aflagte årsregnskab for 1999 for Dansk Institut for Fundamental Metrologi.

Den udførte revision

Revisionen er udført i overensstemmelse med Erhvervsfremme Styrelsens revisionsinstruks pr. 1. Januar 1998 for GTS-institutter under iagtagelse af god offentlig revisionsskik.

Vi har i overensstemmelse med almindeligt anerkendte revisionsprincipper tilrettelagt og udført revisionen med henblik på at opnå en begrundet overbevisning om, at årsregnskabet er uden væsentlige fejl eller mangler. Under revisionen har vi ud fra en vurdering af væsentlighed og risiko efterprøvet grundlaget og dokumentationen for de i årsregnskabet anførte beløb og øvrige oplysninger. Vi har herefter taget stilling til den anvendte regnskabspraksis og de udøvede regnskabsmæssige skøn samt vurderet, om årsregnskabets informationer som helhed er fyldestgørende.

Revisionen har ikke givet anledning til forbehold.

Konklusion

Det er vor opfattelse, at årsregnskabet er aflagt i overensstemmelse med lovgivningens krav til regnskabsaflæggelse herunder de for Dansk Institut for Fundamental Metrologi gældende regnskabsbestemmelser, og at det giver udtryk for årets indtægter og udgifter samt Instituttets aktiver og passiver pr. 31. december 1998.

Forvaltningen af de bevilgede midler er varetaget tilfredsstillende af Dansk Institut for Fundamental Metrologi.

København, 2000-02-21

Juul & Partnere

Niels Bjerregaard
statsautoriseret revisor

6.7 Noter

- 1 Egenfinansierede forsknings- og udviklingsomkostninger, opgjort efter den af Erhvervsfremme Styrelsen godkendte timesats, udgjorde i året 3 621 821 kr.
- 2 DFM har i 1999 i gennemsnit beskæftiget 22 medarbejdere fordelt på 19 faste medarbejdere og 3 konsulenter (blandt andet Ph.D. studerende)
- 3 Anparter i Image Metrologi ApS, Lyngby-Tårnbæk er værdiansat til anskaffelsum. Virksomheden har ikke aflagt årsregnskab

4 Udstyr

Anskaffelsessum	EDB	Videnskabeligt	Kalibrering	Ialt
Saldo 1999 01 01	3 237 401	15 355 536	4 771 001	26 148 214
Tilgang 1999	221163	470901	61 311	980 295
Afgang 1999	(84 858)	(996) -		(97 800)
Saldo 1999 12 31	3 373 706	15 825 441	4 832 312	27 030 709
Afskrivninger				
Saldo 1999 01 01	2 914 396	14 120 433	4 696 619	24 457 235
Afskrivning 1999	275 821	761 918	89 739	1 127 478
Afskrevet årets afgang	(84 858)	(996) -		(97 800)
Saldo 1999 12 31	3 105 359	14 881 354	4 786 358	25 486 913
Bogført værdi	268 349	944 087	45 954	1 485 310

5 Likvide midler

	1999	1998 (1.000 kr)
Statsobligationer 8 % 2003	6 898 640	7 370
Statsobligationer 4 % 2001	492 716	0
Indestående i bank	935 757	3 166
Giro	44 323	36
Likvide midler ialt	8 371 436	10 572

7. How to get to DFM

DFM is situated at the Danish Technical University (DTU) Campus, approximately 15 km north of the centre of Copenhagen.

To find detailed instructions on how to get to DFM, consult the DTU home page at www.dtu.dk, then click "facts" and "transportation to DTU" in the English version.

DFM is located in the third quadrant, building 307, and is most conveniently entered from the east end of the building.

