# Intercomparison Balances

**June 2002 – December 2004**

**January 2005**
**Deutscher Kalibrierdienst, DKD**

## 1. Introduction

The actual standard for the DKD accredited laboratories is the standard ISO 17025 The standard requires to assure the quality of calibration results the participation in interlaboratory comparison programmes. The DKD office in co-operation with the PTB arranges intercomparison measurements for the different accredited measurands. On these intercomparison the laboratories have to participate.

For the non automatic electronic weighing instruments an intercomparison took place between 2002 and 2004 which was embedded in the usual surveillance visit.

In this intercomparison measurement thirteen DKD accredited laboratories and their subcontractors participated:

InfraServ, DKD-K-31401
Rheingaustr. 190 – 196
65174 Wiesbaden

Göntgen Mess- und Wägetechnik, DKD-K-34201
Am Schölsbach 7
46244 Bottrop-Kirchhellen

As-Wägetechnik GmbH, DKD-K-31901
Veit Adam Str. 31
85354 Freising

Sartorius AG, DKD-K-10502
Weender Landstr. 94-108
37075 Göttingen

Fachunternehmen Sartorius
Mewes & Götzl Wäge- und Dosiertechnik GmbH
Otto Lilienthal Str. 7
06796 Brehna Bitterfeld

Mettler - Toledo GmbH, DKD-K-14701
Ockerweg 3
35396 Gießen

Kern & Sohn GmbH, DKD-K-11801
Ziegelei 1
72336 Balingen

Fachunternehmen Kern
Elgleb Wägetechnik
Rudolfstädterstr. 107b
99099 Erfurt

Fachunternehmen Kern
Wilhelm Hachmeister
Stiller Weg 2
32602 Vlotho

LATU, DKD-K-25601
Avenida Italia 6201
Montevideo
Uruguay

Bizerba GmbH & Co. KG, DKD-K-16801
Wilhelm Kraut Str. 65
72336 Balingen

Wolf Jöhnk Wägetechnik, DKD-K-34001
Dorfplatz 2
24582 Groß Buchwald

Zentrum für Messen und Kalibrieren GmbH, DKD-K-06901
Filmstr. 7
06766 Wolfen

## 2. Task

It was the task of the intercomparison measurement to calibrate two non automatic electronic weighing instruments. The balances

Mettler – Toledo, AT 201, *L*max = 205 g, *d* = 0,01 mg and

Sartorius, L2200S, *L*max = 2200 g, *d* = 0,01 g

were located in the PTB mass lab. The calibration method was the method used in the DKD guideline DKD – R 7. The balances were calibrated using the standards of the participants. A calibration certificate with the result of the calibration, the uncertainty function of the balance, was issued and presented to the DKD office.

## 3. Realisation

The intercomparison started in June 2002 and was finished in December 2004.The intercomparison which was a part of the surveillance visit took place in the PTB mass laboratory.

## 4. Result

The expanded uncertainty function was determined for the two balances, AT 201 and L 2200S in accordance to the guideline DKD - R 7.

The expanded uncertainty *U* and the relative uncertainty *W* are presented as function of the load *L* as graph over the range of the balance. With *a* the slope and *b* the intercept of the function.

$$U = a\,L + b$$

$$W = b / L + a$$

The graphs 1 and 4 are showing the linear functions, the expanded uncertainty *U* of the balances.

The graph for the balance AT 201, shows that 10 functions are laying close together and that only 3 have a different slope ( graph 1 ).The graph 2 magnifies these 10 functions. It can be assumed that these 10 functions are representing the expanded uncertainty of the balance. Only two calibration results are showing a large deviation to the others ( lab 6 and lab 11 ). For lab 6 the slope *a* of the uncertainty function is nearly 10 times larger than the slope of the others and lab 11 reaches a relative uncertainty of nearly $W = 1 \cdot 10^{-6}$ for *L*max = 200 g. Which is smaller than the accredited one of $W = 2 \cdot 10^{-6}$.

The functions for the expanded uncertainty *U* and the relative uncertainty *W* for the balance L 2200S are shown on graph 4 and graph 5. Because all the laboratories have nearly reached the same result no corrective actions are necessary for this part of the intercomparison. One participant couldn't calibrate the balance L 2200S because it was used by the laboratory staff.

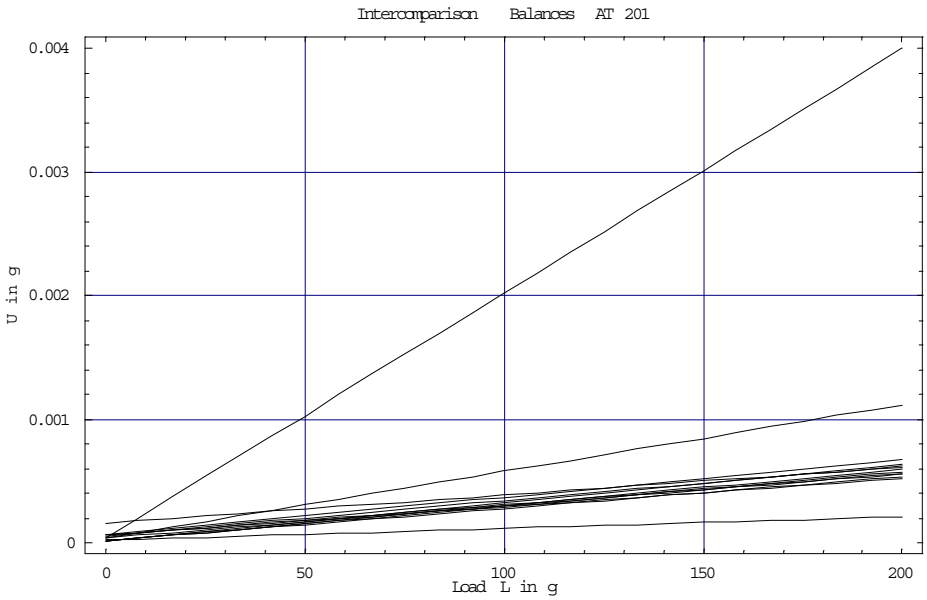
The result of the calibration is a linear uncertainty function of the balance over the range. No measurement results are achieved therefore the standardise deviation, the En – value can't be determined.

### 4.1 Measuring Results

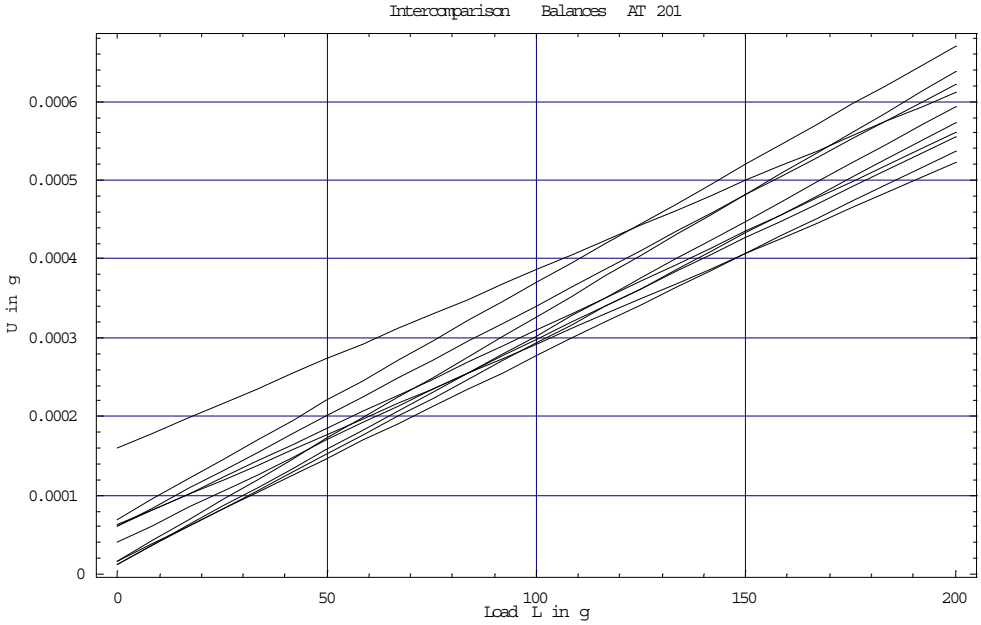
As measuring results the expanded uncertainty *U* as function of the load *L* for the balances AT 201 and L 2200S and the relative uncertainty at max load *L*max = 200 g for the balance AT 201 are shown in the table below. The best measuring capability of the laboratories, the relative uncertainty *W*, are shown in column 2.

| Lab | *Best Measurement Capability accredited* *W* | Balance AT 201 Relative Uncertainty at *L*max | Balance AT 201 Expanded Uncertainty *U* | Balance L 2200S Expanded Uncertainty *U* |
|---|---|---|---|---|
| | | | | |
| 1 | $1 \cdot 10^{-6}$ | $3{,}3 \cdot 10^{-6}$ | 0,07 mg + $3{,}0 \cdot 10^{-6}$ *L* | 0,012 g + $3{,}0 \cdot 10^{-5}$ *L* |
| 2 | $1 \cdot 10^{-6}$ | $2{,}8 \cdot 10^{-6}$ | 0,06 mg + $2{,}5 \cdot 10^{-6}$ *L* | 0,012 g + $6{,}3 \cdot 10^{-5}$ *L* |
| 3 | $1 \cdot 10^{-6}$ | $5{,}6 \cdot 10^{-6}$ | 0,037 mg + $5{,}4 \cdot 10^{-6}$ *L* | keine Waage |
| 4 | $1 \cdot 10^{-6}$ | $3{,}1 \cdot 10^{-6}$ | 0,16 mg + $2{,}3 \cdot 10^{-6}$ *L* | 0,015 g + $5{,}0 \cdot 10^{-5}$ *L* |
| 5 | $1 \cdot 10^{-6}$ | $2{,}8 \cdot 10^{-6}$ | 0,041 mg + $2{,}6 \cdot 10^{-6}$ *L* | 0,013 g + $5{,}8 \cdot 10^{-5}$ *L* |
| 6 | $1 \cdot 10^{-6}$ | **$2{,}0 \cdot 10^{-5}$** | 0,038 mg + $2{,}0 \cdot 10^{-5}$ *L* | 0,014 g + $4{,}1 \cdot 10^{-5}$ *L* |
| 7 | $1 \cdot 10^{-6}$ | $2{,}7 \cdot 10^{-6}$ | 0,017 mg + $2{,}6 \cdot 10^{-6}$ *L* | 0,012 g + $6{,}7 \cdot 10^{-5}$ *L* |
| 8 | $1 \cdot 10^{-6}$ | $2{,}8 \cdot 10^{-6}$ | 0,013 mg + $2{,}8 \cdot 10^{-6}$ *L* | 0,012 g + $5{,}0 \cdot 10^{-5}$ *L* |
| 9 | $1 \cdot 10^{-6}$ | $3{,}1 \cdot 10^{-6}$ | 0,061 mg + $2{,}8 \cdot 10^{-6}$ *L* | 0,021 g + $4{,}7 \cdot 10^{-5}$ *L* |
| 10 | $1 \cdot 10^{-6}$ | $2{,}6 \cdot 10^{-6}$ | 0,062 mg + $2{,}3 \cdot 10^{-6}$ *L* | 0,013 g + $5{,}1 \cdot 10^{-5}$ *L* |
| 11 | $2 \cdot 10^{-6}$ | **$1{,}1 \cdot 10^{-6}$** | 0,022 mg + $9{,}5 \cdot 10^{-7}$ *L* | 0,012 g + $5{,}7 \cdot 10^{-5}$ *L* |
| 12 | $2 \cdot 10^{-6}$ | $3{,}0 \cdot 10^{-6}$ | 0,013 mg + $2{,}9 \cdot 10^{-6}$ *L* | 0,012 g + $4{,}9 \cdot 10^{-5}$ *L* |
| 13 | $2 \cdot 10^{-6}$ | $3{,}2 \cdot 10^{-6}$ | 0,017 mg + $3{,}1 \cdot 10^{-6}$ *L* | 0,010 g + $6{,}0 \cdot 10^{-5}$ *L* |

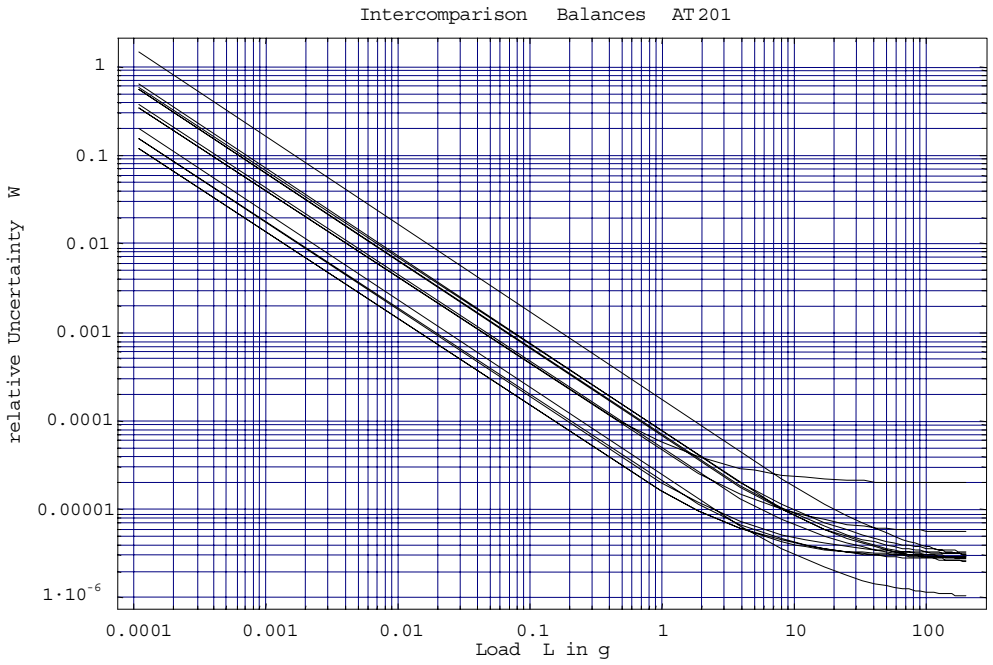
## 4. 2 Presentation of the results for the balance AT 201




Graph 1: Expanded measurement uncertainty *U* as function of the load *L*

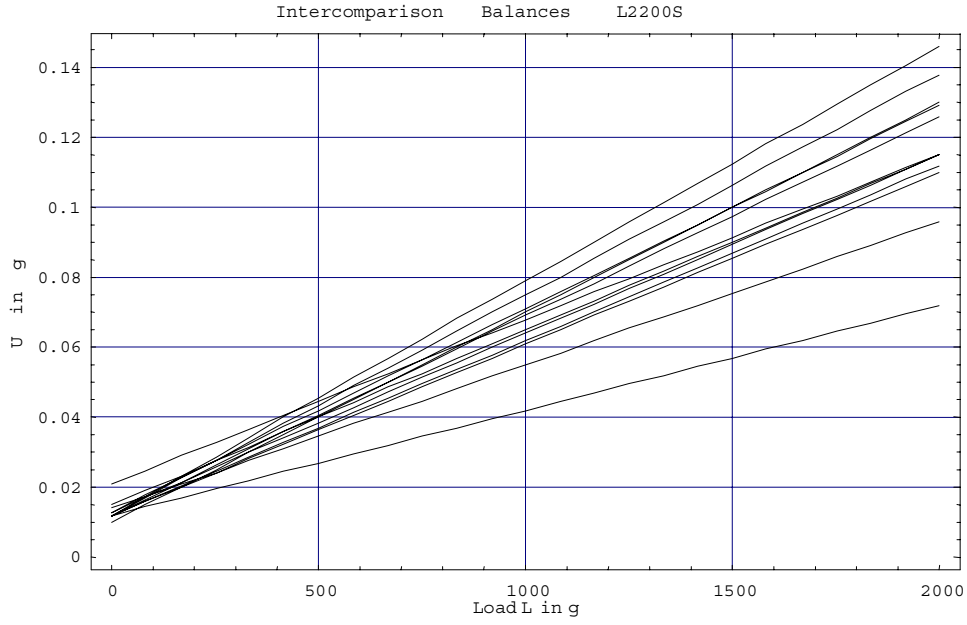



Graph 2: The 10 similar functions from the graph above magnified

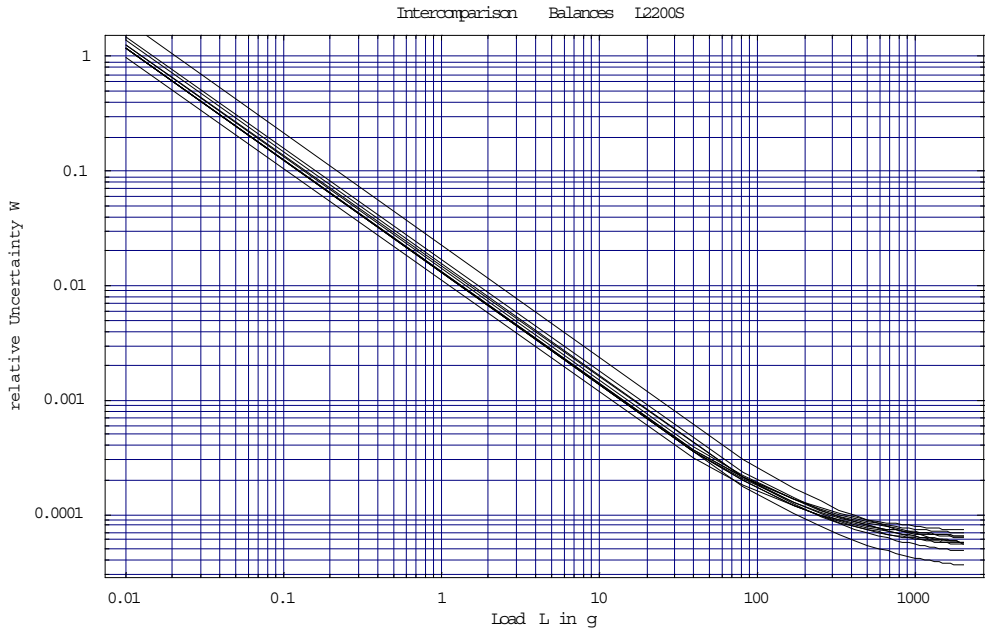



Graph 3: Relative uncertainty *W* as function of the load *L*

## 4.3 Presentation of the results for the balance L 2200S




Graph 4: Expanded uncertainty *U* as function of the load *L*




Graph 5: Relative uncertainty *W* as function of the load *L*

## 5. Check of the Nonconformities

The laboratories 6 and 11 have been informed about the deviation of the result. They started the procedures “Control of Nonconforming Calibration Work” and “Corrective Actions”.

For lab 6 the cause analysis showed that the weight set was not acclimated. The working instruction of the laboratory requires in a case like this that a relative uncertainty of $W = 2 \cdot 10^{-5}$ should be assumed which had be done.

Lab 11 determined a relative uncertainty for the max. load which was smaller than the best measurement capability for which the lab was accredited. The evaluation programme has been changed so that an uncertainty smaller than the best measurement capability will not be reached.

## 6. Summary

The intercomparison measurement has shown that all the participants have reached for the precision balance L 2200S nearly the same results. It can be concluded for all laboratories a good conformity in the measuring methods, evaluation software and technical know how.

For the balance AT 201 eleven participants reached nearly similar results. Only two participants have shown a deviation where corrective actions were necessary.

After the DKD has accepted the new EA guideline for the calibration of non automatic measuring instruments, the intercomparison should be repeated using the new guideline. Also the evaluation software should be checked.