Intern kvalitetskontroll - hvordan bør det gjøres?

Elvar Theodorsson

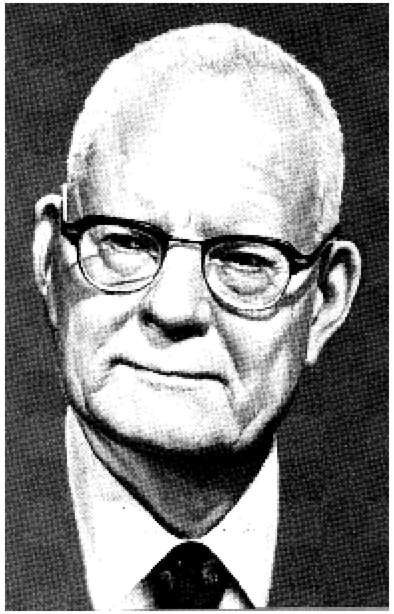
Quality management-, assurance- and control have their roots in the telephone industry

Western Electric Company

- 1905, Hawthorne Works, near to Chicago, employing 45 000 persons
- ”Hawthorne effect” - individuals modify their behaviour in response to their awareness of being observed
- **Walter A. Shewhart**

W. Edwards Deming

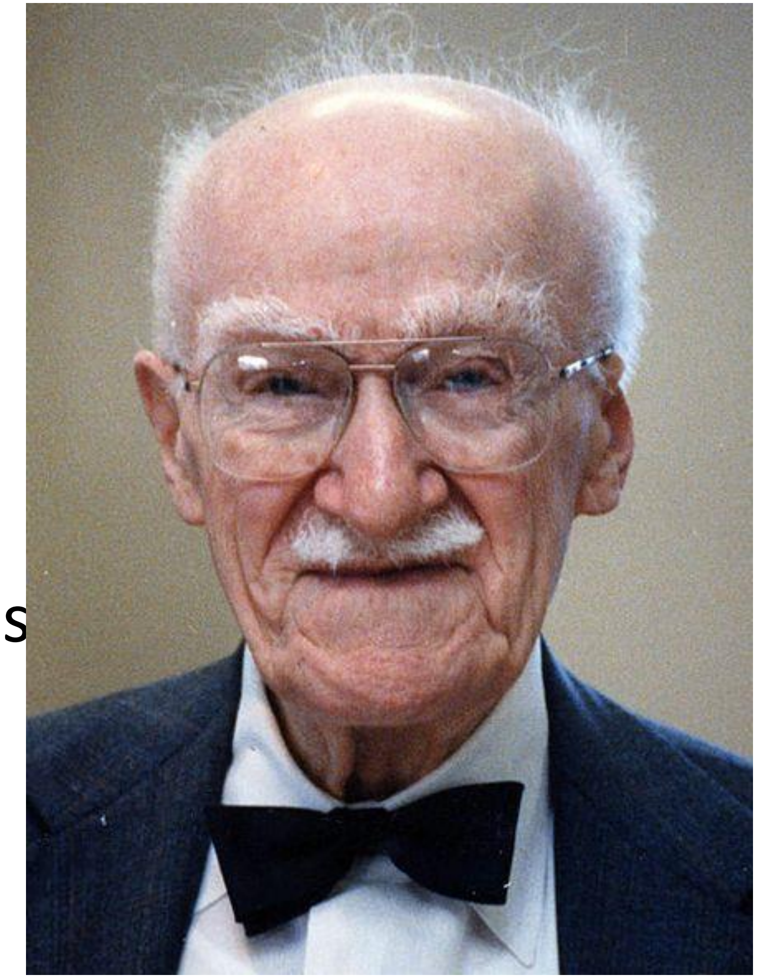
- Worked with Shewhart in the 1930:s at Western Electric
- Studied under Sir Ronald Fisher and Jerzy Neyman at University College, London in 1936
- Book: “Statistical Method from the Viewpoint of Quality Control”, 1936
- Worked in Japan from 1947
- Deming orthogonal regression



$$\text{Quality} = \frac{\text{Results of work efforts}}{\text{Total costs}}$$

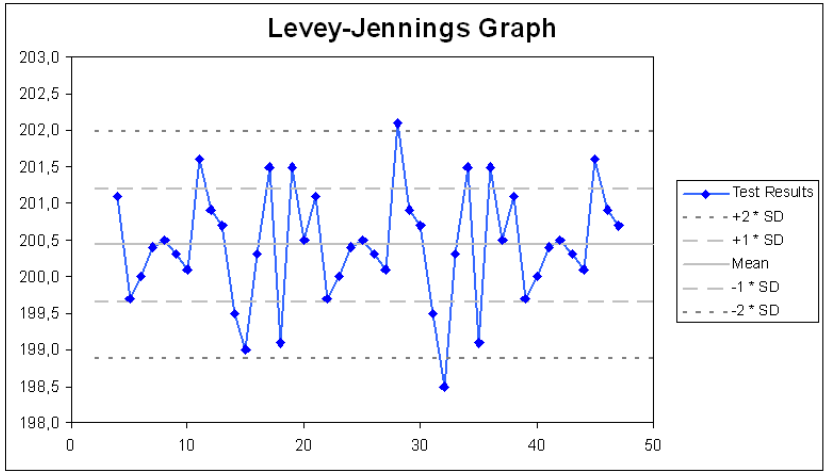
Joseph M. Juran

- Western Electric, Hawthorn, 1924
- Focused on management for quality
- Worked in Japan from 1954
- Juran´s ”Quality Control Handbook” 1951
- Pareto principle – ”roughly 80% of the effects come from 20% of the causes”



Levey-Jennings control chart

- The distance from the mean is measured in standard deviations (SD)



Henry and Segalove control chart

- The relation to events, especially dates plotted on the X-axis

J. clin. Path. (1952), 5, 305.

THE RUNNING OF STANDARDS IN CLINICAL CHEMISTRY AND THE USE OF THE CONTROL CHART

BY

RICHARD J. HENRY AND MILTON SEGALOVE

From the Bio-Science Laboratories, Beverly Hills, California

(RECEIVED FOR PUBLICATION JANUARY 4, 1952)

Westgard, de Verdier, Groth, Aronsson

- Westgard JO, Groth T, Aronsson T, Falk H, de Verdier CH (1977) Performance characteristics of rules for internal quality control: probabilities for false rejection and error detection. Clin Chem 23: 1857–1867.
- Multirules
- Power function graphs

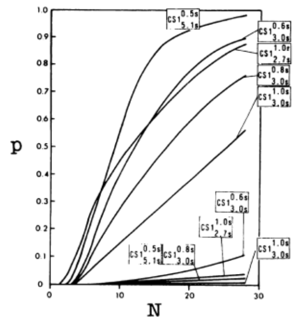
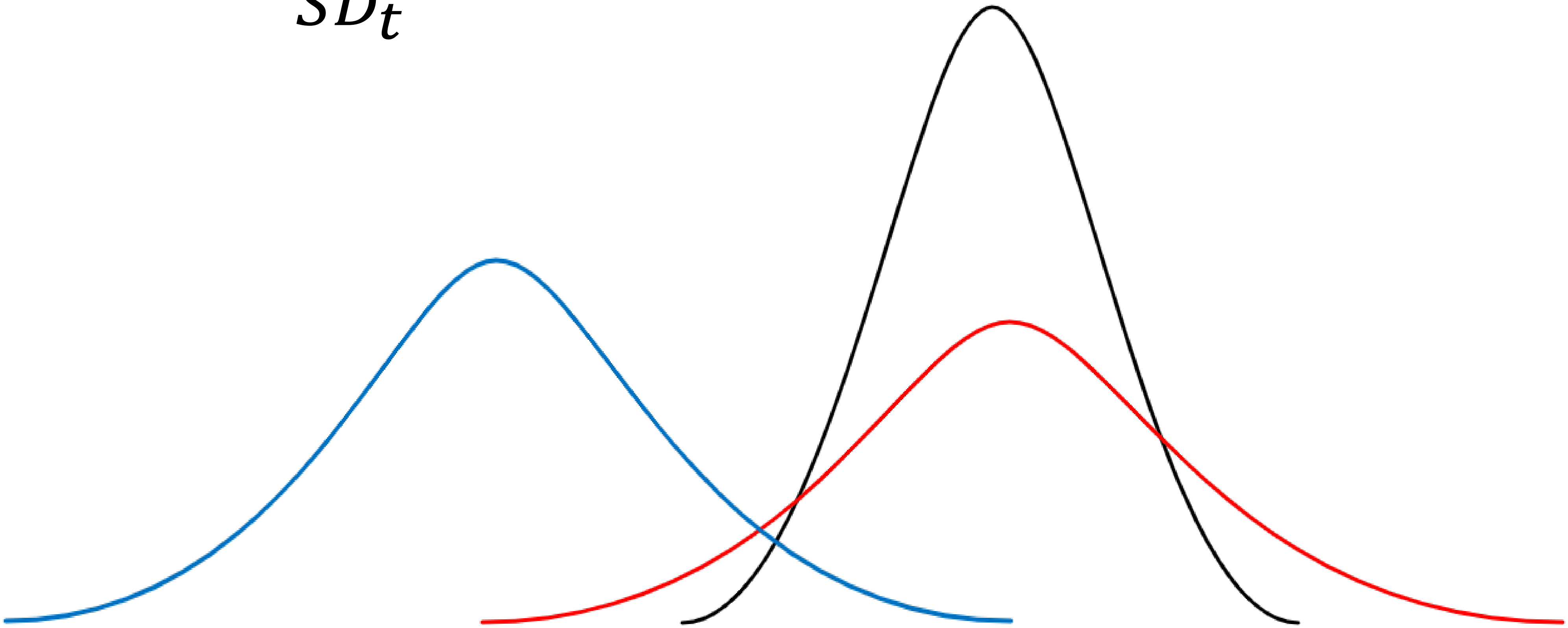
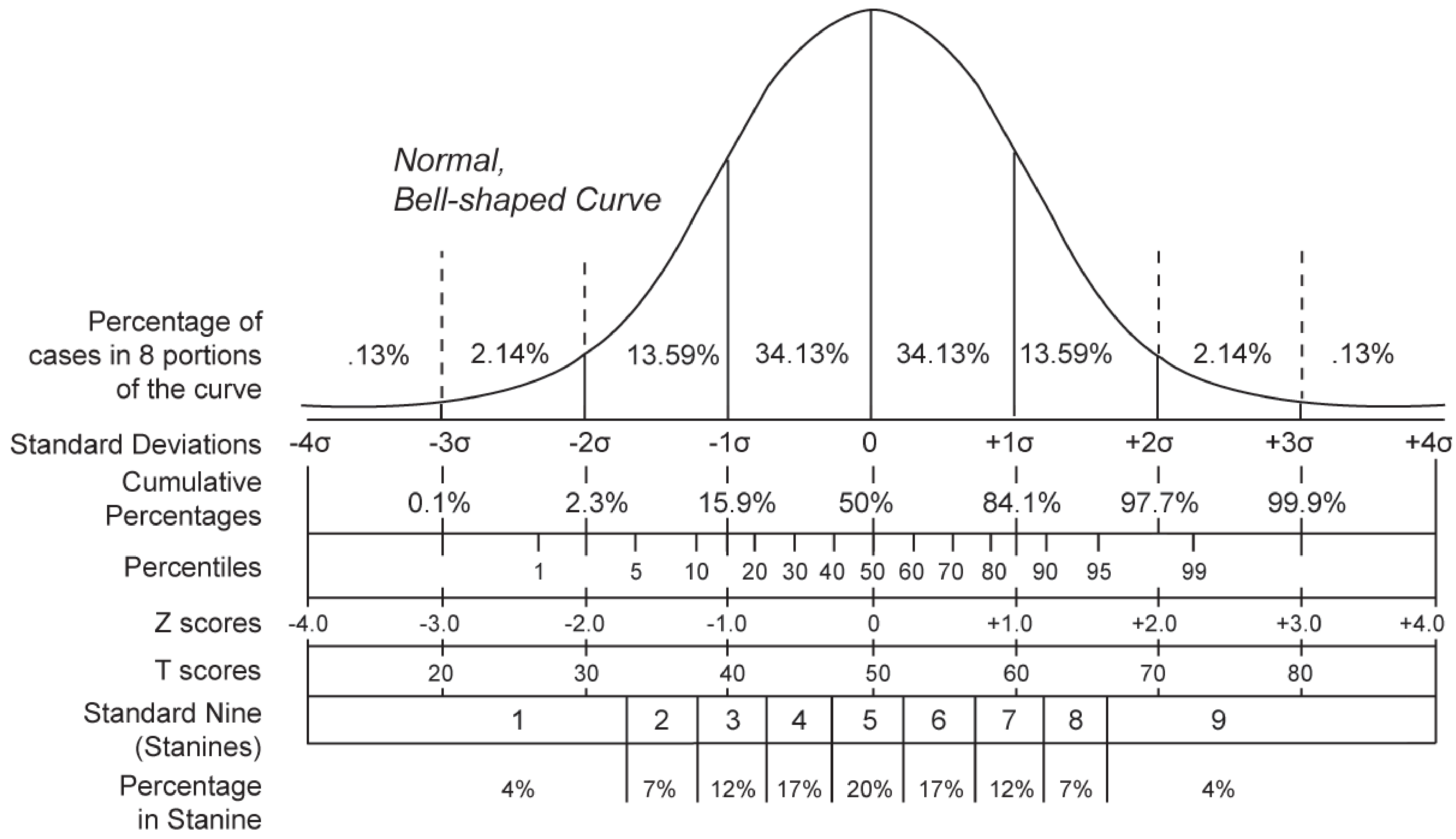


Fig. 4. Responses of individual decision limit cusum control rules to a *systematic shift equivalent to 1.0s* (top part of figure) and *when no analytical errors are present* (bottom part of figure)
In Figures 4–9, the probability for rejection (*p*) is plotted vs. the number of control observations (N)

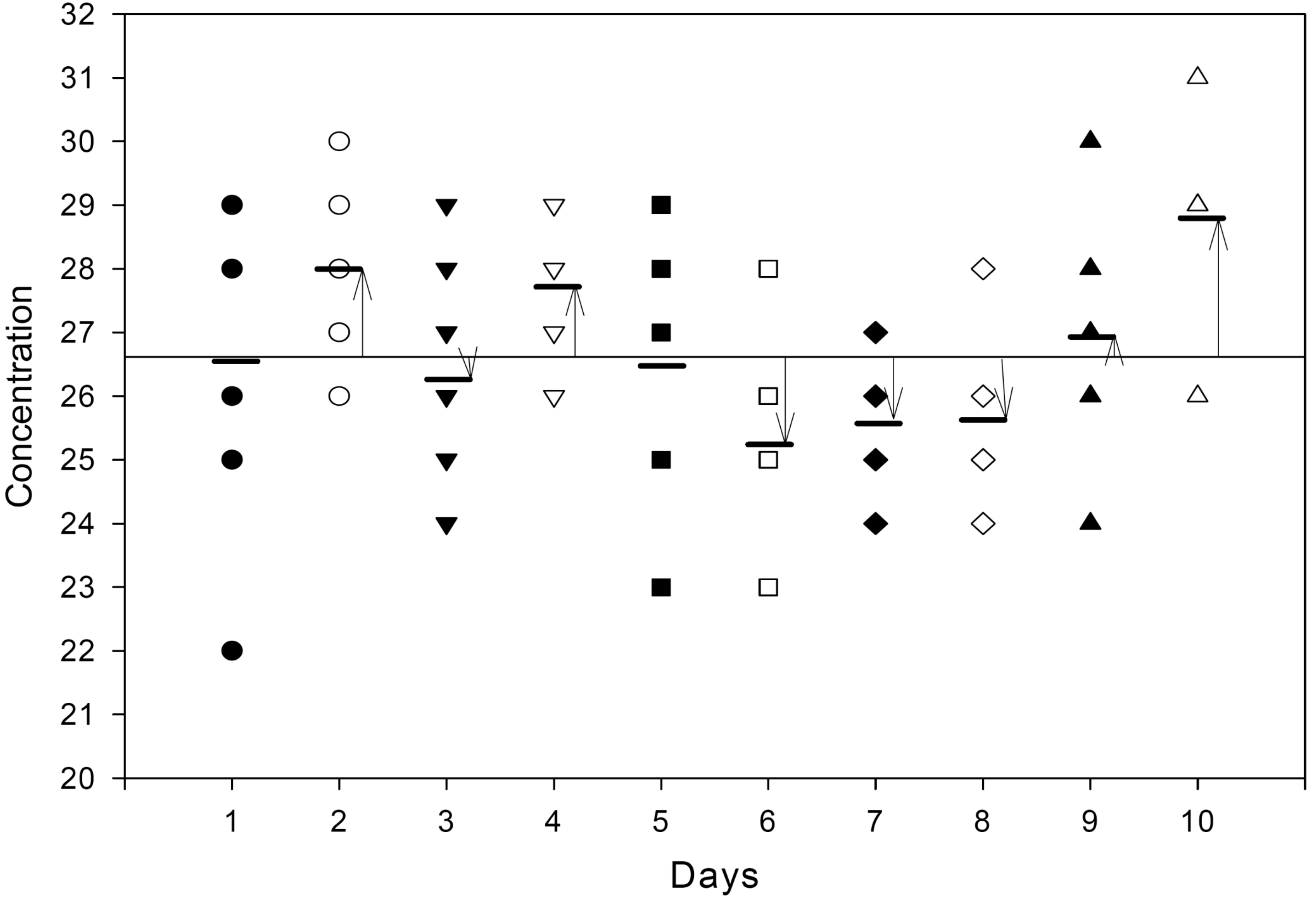
$$\text{Z-score} = \frac{x_i - \bar{x}}{SD_t}$$





Normal,
Bell-shaped Curve
Percentage of cases in 8 portions of the curve
.13%
2.14%
13.59%
34.13%
34.13%
13.59%
2.14%
.13%
Standard Deviations
-4σ -3σ -2σ -1σ 0 +1σ +2σ +3σ +4σ
Cumulative Percentages
0.1% 2.3% 15.9% 50% 84.1% 97.7% 99.9%
Percentiles
1 5 10 20 30 40 50 60 70 80 90 95 99
Z scores
-4.0 -3.0 -2.0 -1.0 0 +1.0 +2.0 +3.0 +4.0
T scores
20 30 40 50 60 70 80
Standard Nine (Stanines)
1 2 3 4 5 6 7 8 9
Percentage in Stanine
4% 7% 12% 17% 20% 17% 12% 7% 4%

Repeatability and Reproducibility



$$CV\% = \frac{SD}{\bar{x}}$$

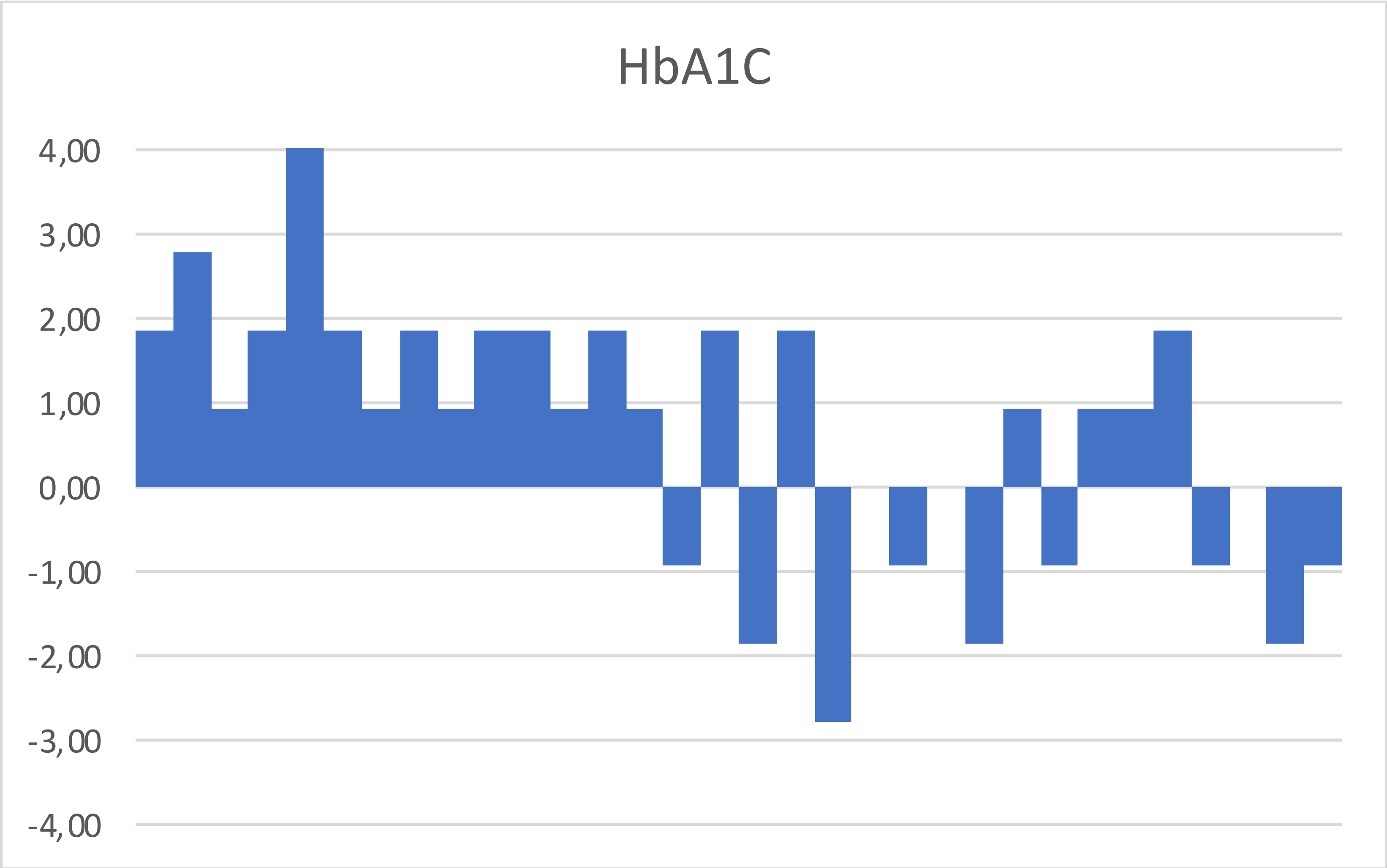
$$CV_t^2\% = CV_w^2\% + CV_b^2\%$$

w=repeatability imprecision

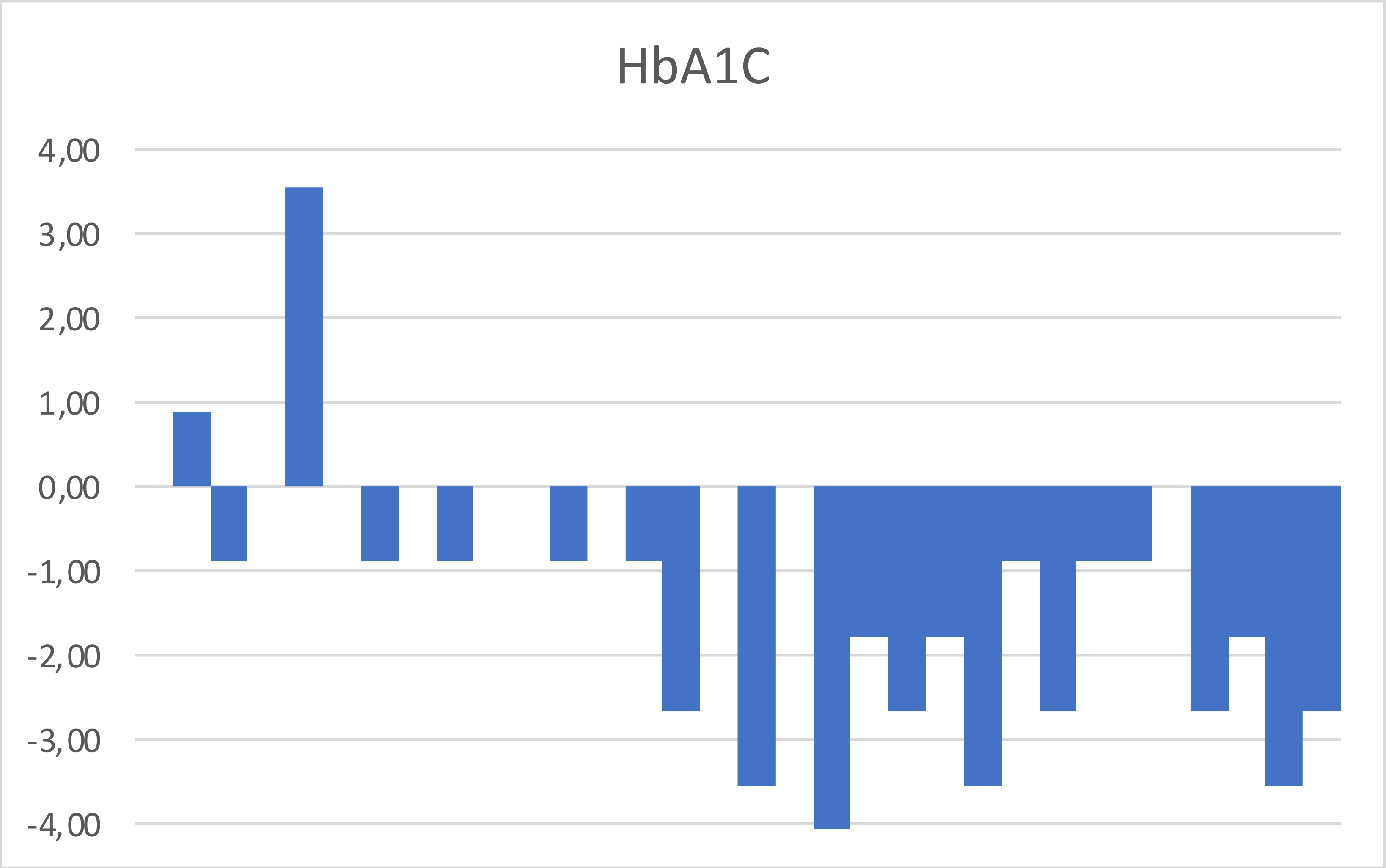
b=repreproducibility imprecision

$$SD_t = \frac{CV_t\% * \bar{x}}{100}$$

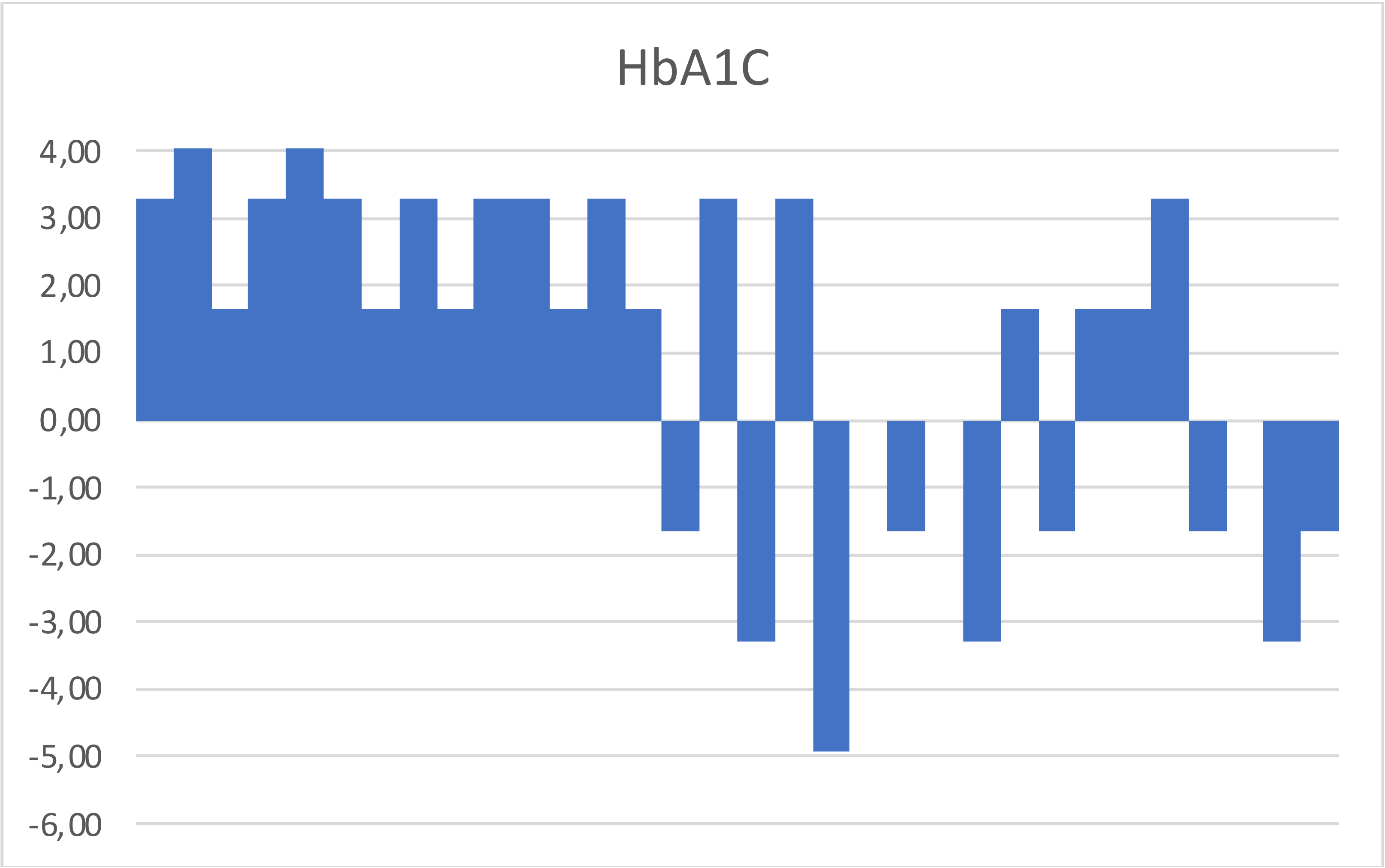
Z-score= $\frac{x_i - \bar{x}}{SD_t}$



Mean = 4.3
CWw = 1.5
CVb = 2

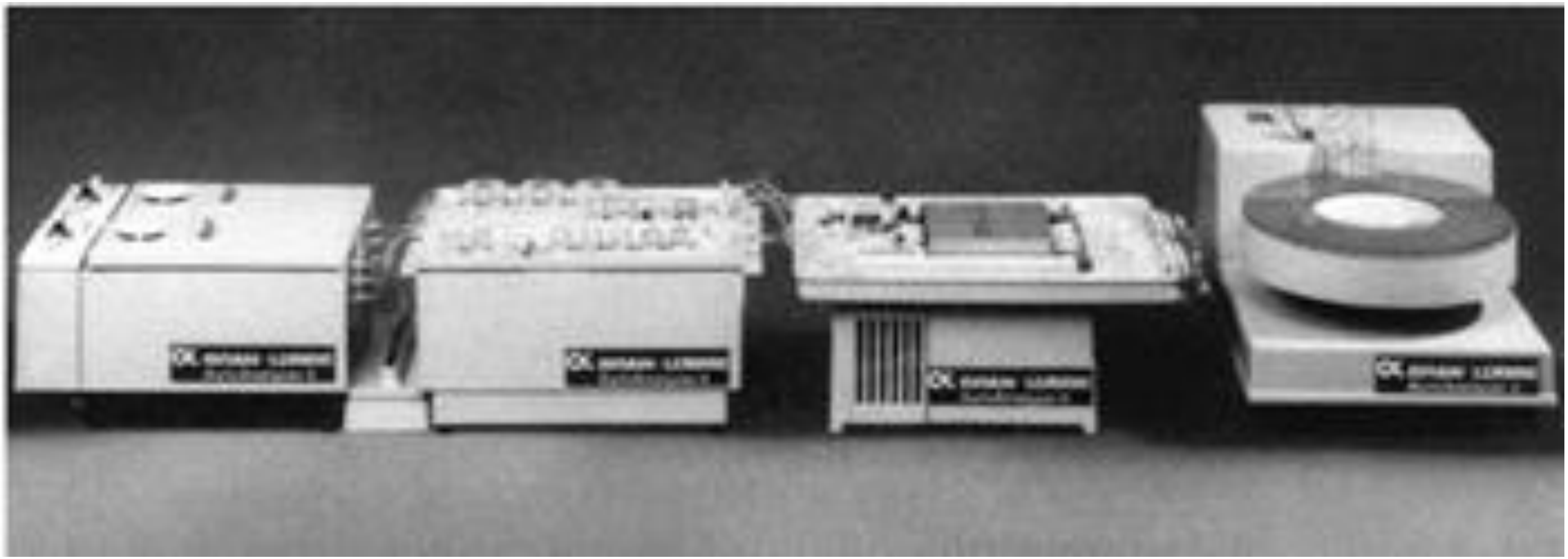


Mean = 4.5
CWw = 1.5
CVb = 2



Mean = 4.3
CWw = 1
CVb = 1

Technicon AutoAnalyzer II in the 1970´es



The SEAL AutoAnalyzer 3 HR is the most recent version of the original AutoAnalyzer ll. It's designed specifically for industrial and environmental sample analysis

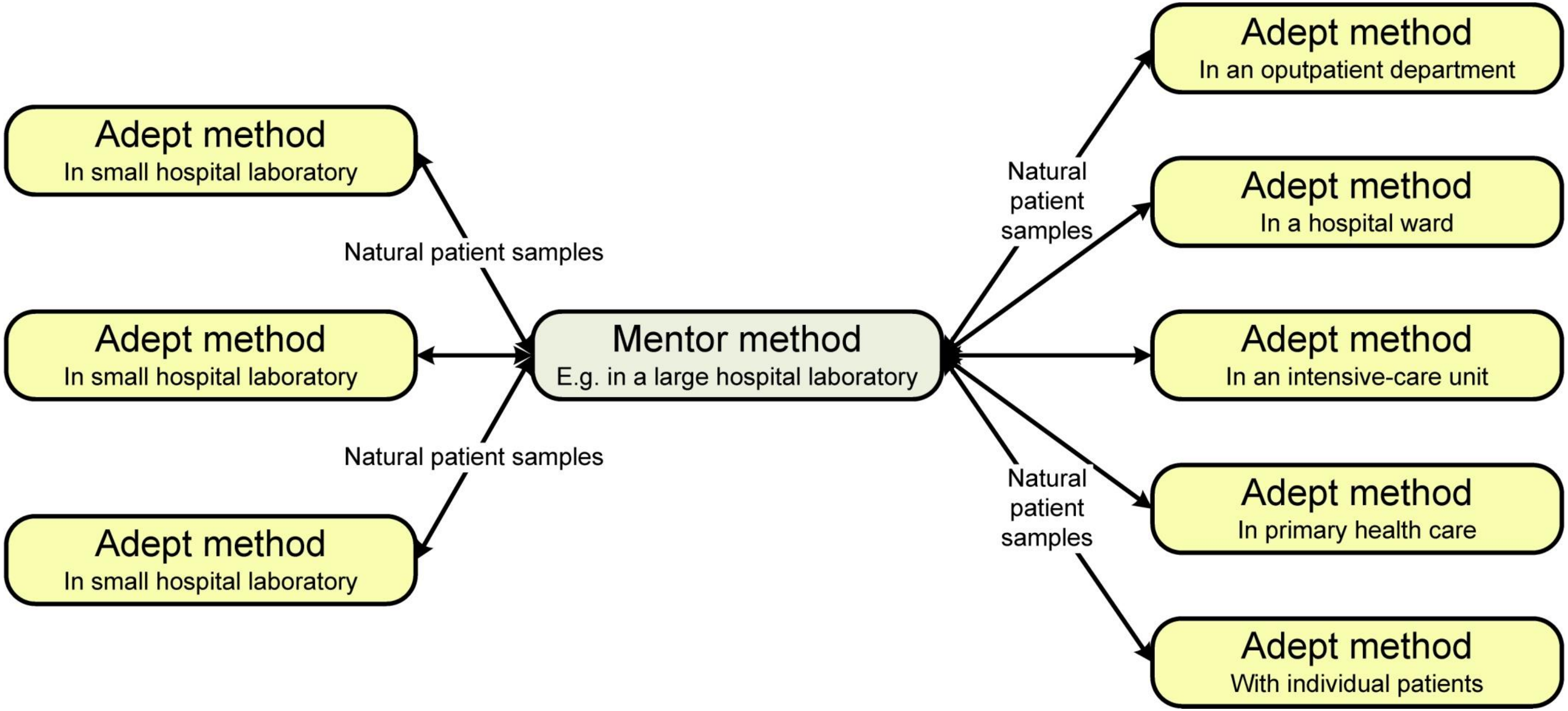
In practice 1(2)

1. Use the same stabilized control material for internal quality control for the same measurand for all measuring systems in the whole laboratory organization
   - Purchase at least a one year supply of the same lot number of the control material
2. The **imprecision** (repeatability + reproducibility) is usually stable as lot numbers change/re-calibrations are performed
3. Change of lot numbers/re-calibrations commonly make **change of expected mean value** mandatory.
   - Otherwise, statistical control rules (e.g. 1_{3S} 2_{2S} 10_{X}) give incorrect singnals.
   - Change of expected mean values for the same control material is not cheating

In practice 2(2)

4. **Do not overcomplicate** the use of control rules
   - 1_{3S} 2_{2S} 10_X may e.g. serve you well when intelligently used
5. Calculate the **total uncertainty** (repeatability variance + reproducibility variance) at least every month as far back as the same lot number of the internal quality control material was used
   - The total uncertainty will then include both the imprecision and the varying biases caused by the lot-number changes/re-calibrations
   - The total uncertainty is an appropriate measure of the measurement uncertainty component of the **diagnostic uncertainty** when using the measurand in question for clinical diagnosis

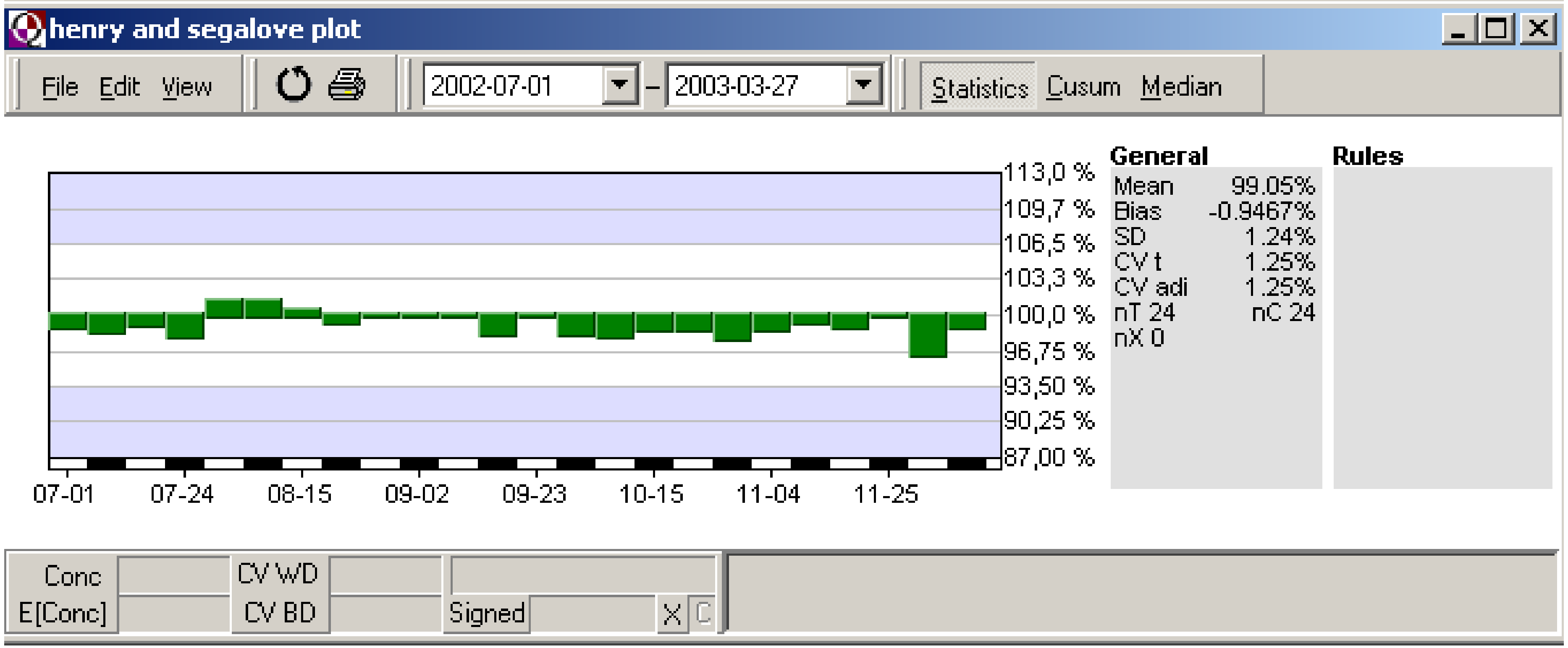
Reproducibility measurement uncertainty using natural patient samples



Norming results

$$\text{Normed result} = \frac{\text{Adept - Mentor}}{\text{Mentor}} * 100$$

Norming the results



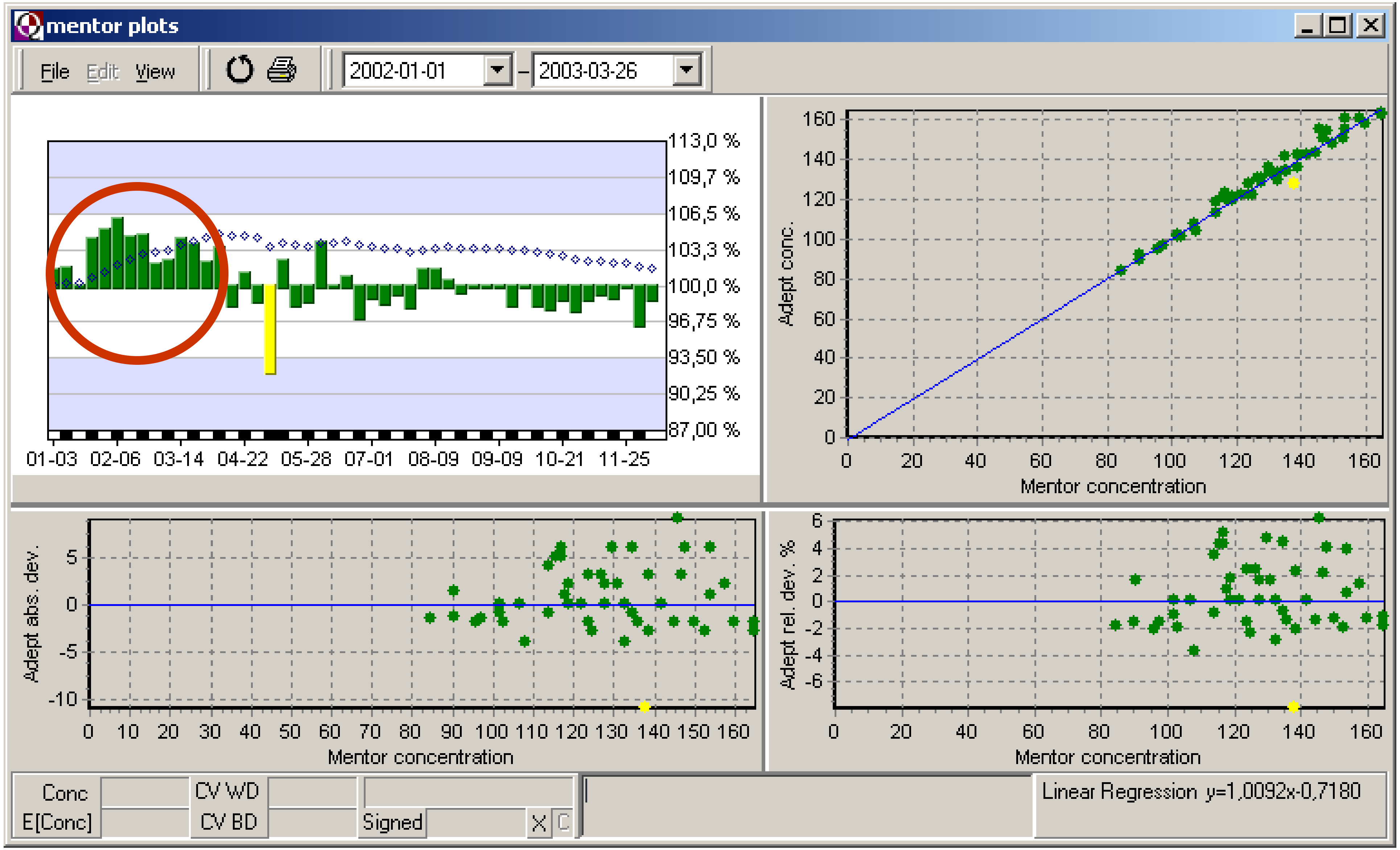
The results from the adept instrument/method as a negative bias of about 1% compared to the mentor instrument. This bias varies with a standard deviation of 1.24%

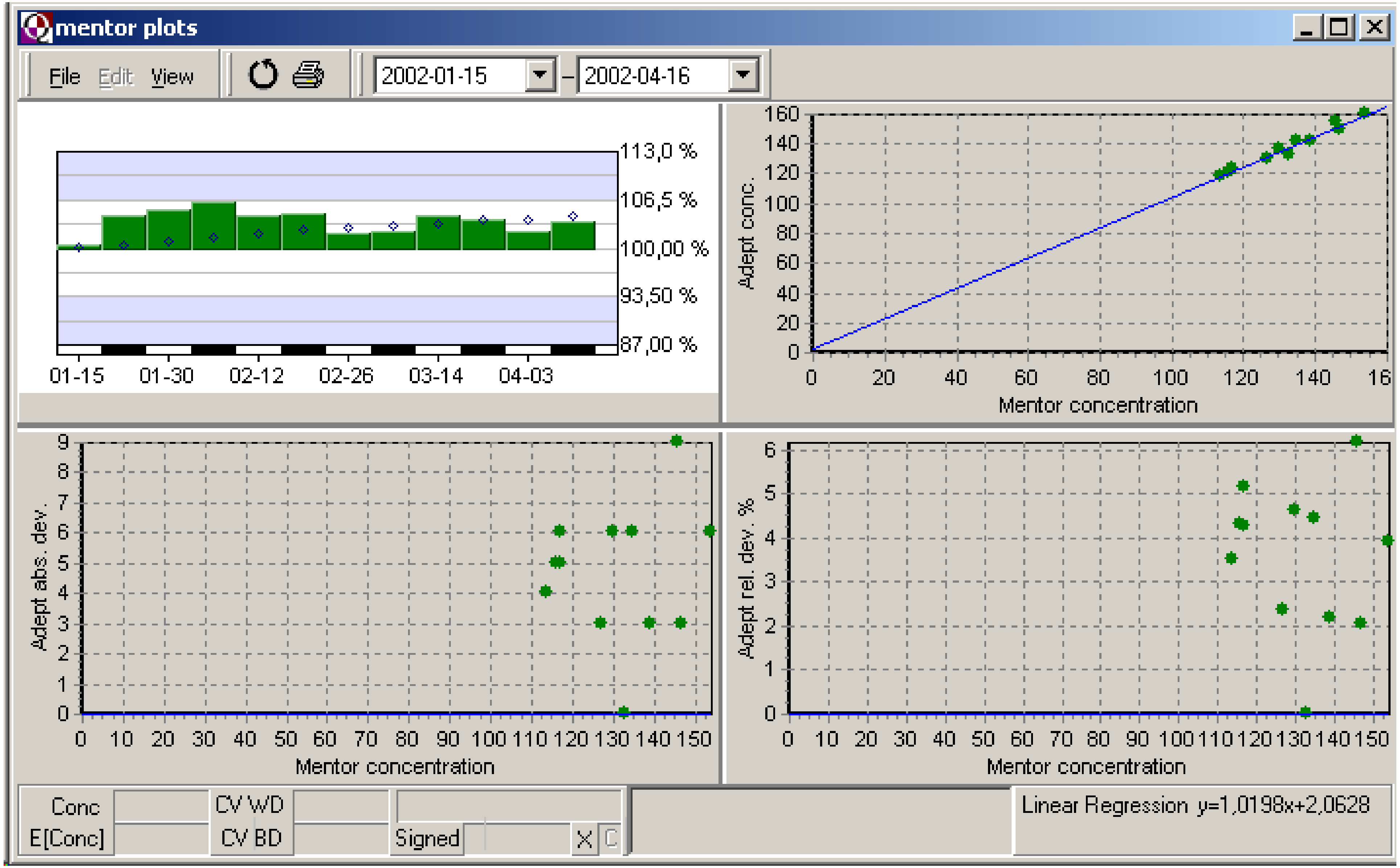
Norming the results

Express each of the adept values as a percent of the corresponding mentor value.

”The results of the adept method in this case is about 1% lower than the measurements performed on the mentor instrument. This bias varies with a standard deviation of 1,24%

Tidsstämpel	Instrument	Adept	Mentor	Normerat värde
2002-07-01 12:00	925	163,0	165,0	98,79%
2002-07-09 09:40	925	96,0	97,6	98,36%
2002-07-15 07:30	925	101,0	102,0	99,02%
2002-07-24 10:00	925	94,0	96,0	97,92%
2002-07-29 09:40	925	130,0	128,0	101,56%
2002-08-09 10:00	925	133,0	131,0	101,53%
2002-08-15 09:29	925	155,0	154,0	100,65%
2002-08-21 10:09	925	134,0	135,0	99,26%
2002-08-30 10:30	925	119,0	119,0	100,00%
2002-09-02 12:49	925	102,0	102,0	100,00%
2002-09-09 11:10	925	122,0	122,0	100,00%
2002-09-16 07:59	925	150,0	153,0	98,04%
2002-09-23 10:50	925	128,0	128,0	100,00%
2002-10-02 09:00	925	83,0	84,6	98,11%
2002-10-08 10:00	925	136,0	139,0	97,84%
2002-10-15 09:35	925	143,0	145,0	98,62%
2002-10-21 10:02	925	143,0	145,0	98,62%
2002-10-28 10:30	925	122,0	125,0	97,60%
2002-11-04 11:39	925	134,0	136,0	98,53%
2002-11-12 14:35	925	113,0	114,0	99,12%
2002-11-19 08:50	925	158,0	160,0	98,75%
2002-11-25 10:20	925	142,0	142,0	100,00%
2002-12-02 10:50	925	104,0	108,0	96,30%
2002-12-09 11:10	925	148,0	150,0	98,67%
			Medelvärde	**99,05%**
			SD	**1,24%**

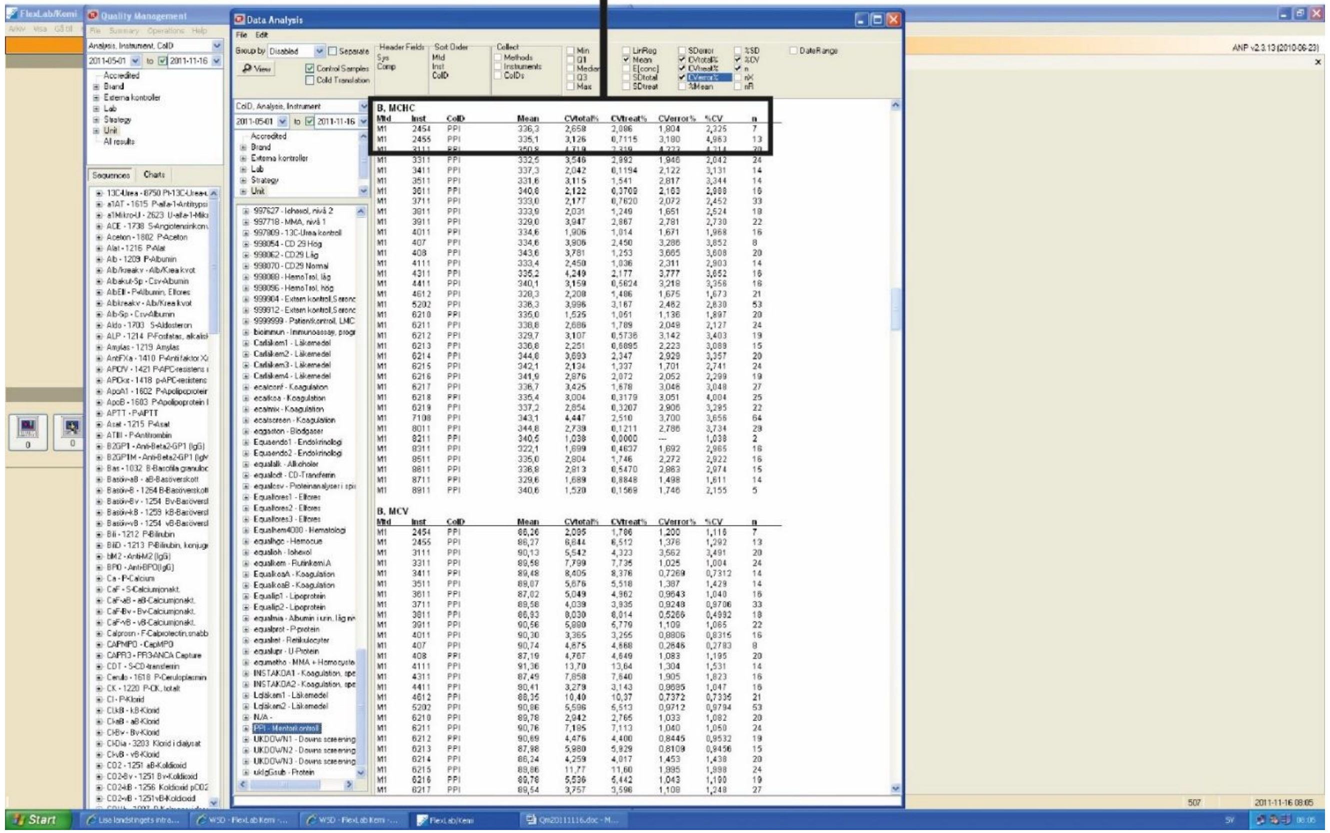

mentor plots
File Edit View
2002-01-01 – 2003-03-26
113,0 %
109,7 %
106,5 %
103,3 %
100,0 %
96,75 %
93,50 %
90,25 %
87,00 %
01-03 02-06 03-14 04-22 05-28 07-01 08-09 09-09 10-21 11-25
Adept conc.
Mentor concentration
Adept abs. dev.
Mentor concentration
Adept rel. dev. %
Mentor concentration
Conc
E[Conc]
CV WD
CV BD
Signed
Linear Regression y=1,0092x-0,7180


mentor plots
File Edit View
2002-01-15
2002-04-16
113,0 %
106,5 %
100,00 %
93,50 %
87,00 %
01-15 01-30 02-12 02-26 03-14 04-03
Adept conc.
Mentor concentration
Adept abs. dev.
Mentor concentration
Adept rel. dev. %
Mentor concentration
Conc
E[Conc]
CV WD
CV BD
Signed
Linear Regression y=1,0198x+2,0628

Variance component analysis

B, MCHC

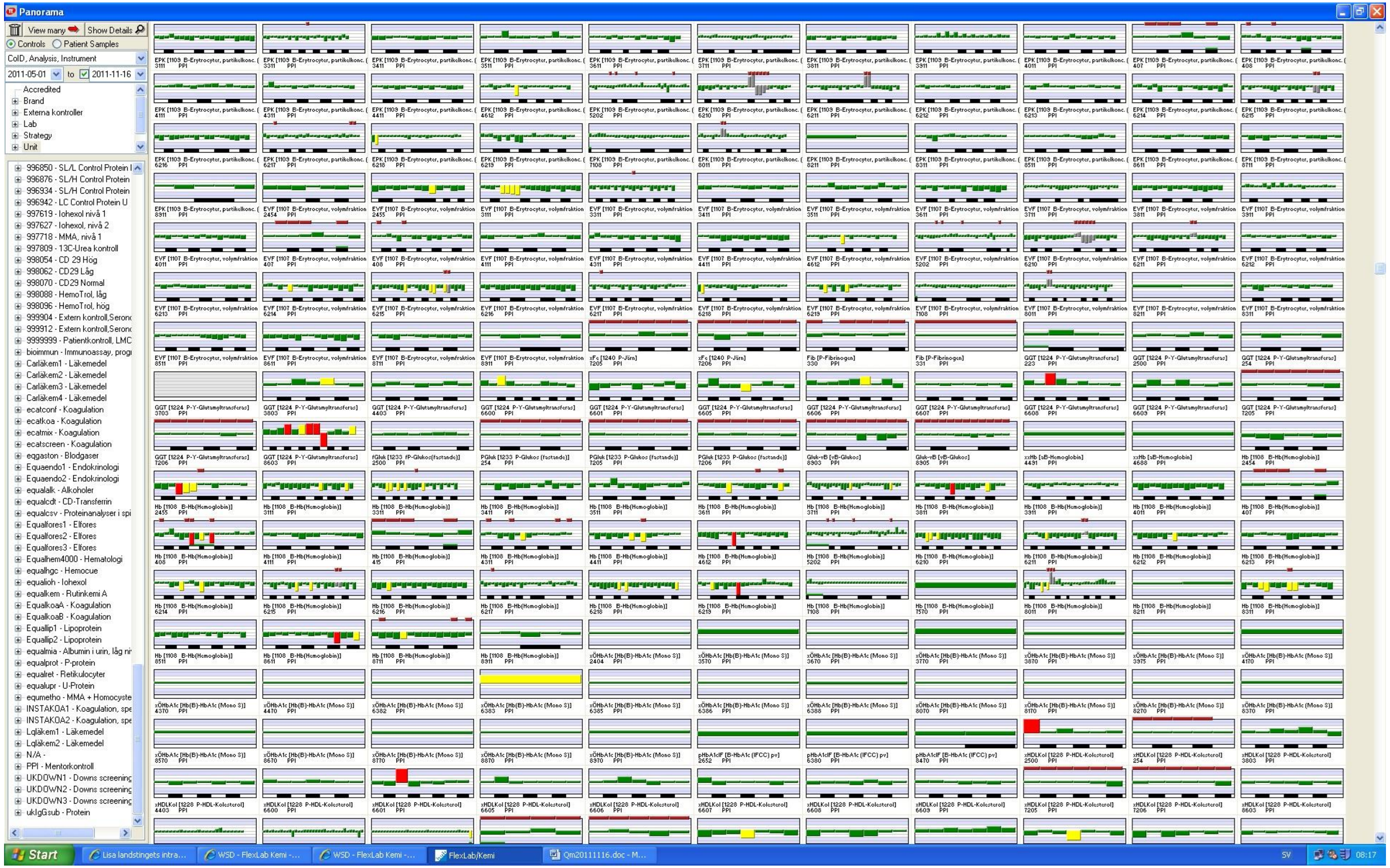
Mtd	Inst	ColD	Mean	CVtotal%	CVtreat%	CVerror%	%CV	n
M1	2454	PPI	336,3	2,658	2,086	1,804	2,325	7
M1	2455	PPI	335,1	3,126	0,7115	3,180	4,963	13
M1	3111	PPI	350,8	4,719	2,319	4,222	4,214	20
M1	3311	PPI	332,5	3,546	2,992	1,946	2,042	24



Investigating which of the following

- Measuring system
- Reagents
- Laboratory
- Operator

Contributes most to the overall diagnostic uncertainty


Panorama
View many
Show Details
Controls
Patient Samples
ColD, Analysis, Instrument
2011-05-01
to
2011-11-16
Accredited
Brand
Externa kontroller
Lab
Strategy
Unit
996850 - SL/L Control Protein I
996876 - SL/H Control Protein
996934 - SL/H Control Protein
996942 - LC Control Protein U
997619 - Iohexol nivå 1
997627 - Iohexol, nivå 2
997718 - MMA, nivå 1
997809 - 13C-Urea kontroll
998054 - CD 29 Hög
998062 - CD29 Låg
998070 - CD29 Normal
998088 - HemoTrol, låg
998096 - HemoTrol, hög
999904 - Extern kontroll,Seronc
999912 - Extern kontroll,Seronc
9999999 - Patientkontroll, LMC
bioimmun - Immunoassay, progr
Carläkem1 - Läkemedel
Carläkem2 - Läkemedel
Carläkem3 - Läkemedel
Carläkem4 - Läkemedel
ecatconf - Koagulation
ecatkoa - Koagulation
ecatmix - Koagulation
ecatscreen - Koagulation
eqgaston - Blodgaser
Equaendo1 - Endokrinologi
Equaendo2 - Endokrinologi
equalalk - Alkoholer
equalcdt - CD-Transferrin
equalcsv - Proteinanalyser i spi
Equalfores1 - Elfores
Equalfores2 - Elfores
Equalfores3 - Elfores
Equalhem4000 - Hematologi
equalhgc - Hemocue
equalioh - Iohexol
equalkem - Rutinkemi A
EqualkoaA - Koagulation
EqualkoaB - Koagulation
Equallip1 - Lipoprotein
Equallip2 - Lipoprotein
equalmia - Albumin i urin, låg ni
equalprot - P-protein
equalret - Retikulocyter
equalupr - U-Protein
equmetho - MMA + Homocyste
INSTAKOA1 - Koagulation, spe
INSTAKOA2 - Koagulation, spe
Lqläkem1 - Läkemedel
Lqläkem2 - Läkemedel
N/A -
PPI - Mentorkontroll
UKDOWN1 - Downs screening
UKDOWN2 - Downs screening
UKDOWN3 - Downs screening
ukIgGsub - Protein
Start
Lisa landstingets intra...
WSD - FlexLab Kemi -...
WSD - FlexLab Kemi -...
FlexLab/Kemi
Qm20111116.doc - M...
SV
08:17

Osbstacles to mentor-adept methods and to secondary adjustments

- Regulatory organizations including the EU (IVD) and the FDA
- Accreditation authorities
- Risks isolating the adept laboratories from the community of laboratories participating in regular external quality control/proficiency testing schemes

Important components of IQC

- Stabilized control materials
  - At least two levels
  - Enough for at least one year of use in the the entire laboratory organization
- Natural patient samples
  - Commutability
  - Trust
  - An appropriate IT system is needed
- Thourough knowledge of the statistical principles needed
- Single laboratory or all laboratories and measurement systems in the laboratory organization