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Österreichisches Forschungsinstitut
für Chemie und Technik

Austrian Research Institute for Chemistry and Technology

- ISSS round robin 2010

Philipp Koskarti

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BIOENERGIE

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content

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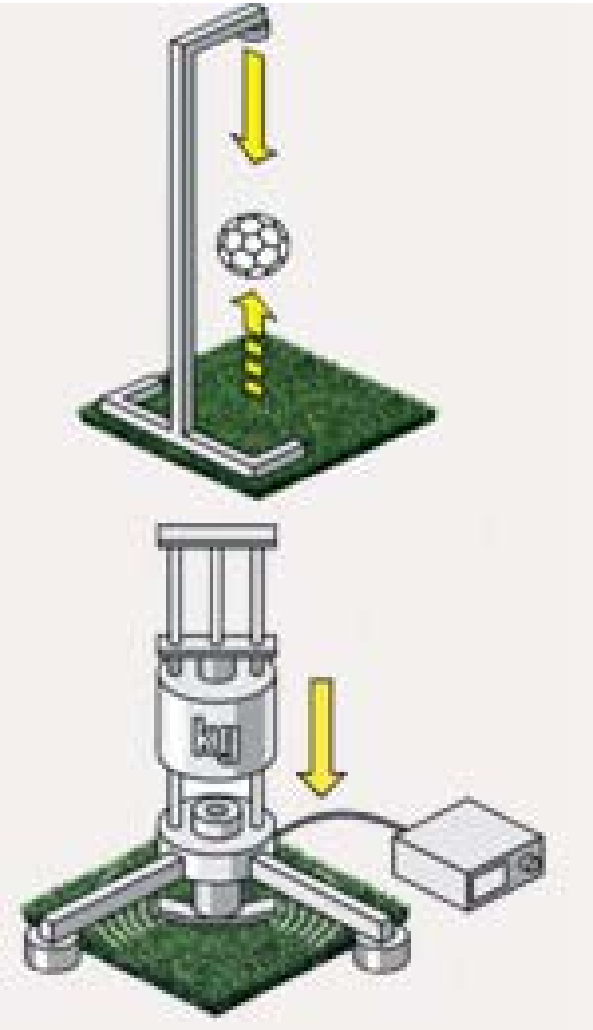
- Details of the RR
  - Determination of vertical ball behaviour (EN 12235:2004)
  - Determination of vertical deformation (EN 14809:2005)
  - Determination of shock absorption (EN 14808:2005)
- Results / Evaluation
- Conclusions



Source: ACT Global Sports

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Why round robin tests?

- Ring tests, Round robin tests (one and the same sample), interlaboratory comparison tests, proficiency test
- Evaluation of the **performance** of the participating laboratories (ISO/IEC-Guide 43-1)
- Evaluation of the **precision** of the test methods (ISO 5725)
- Estimation of **measurement uncertainty**
- Identification of **troubles**
- Support for **accredited laboratories** (audits)

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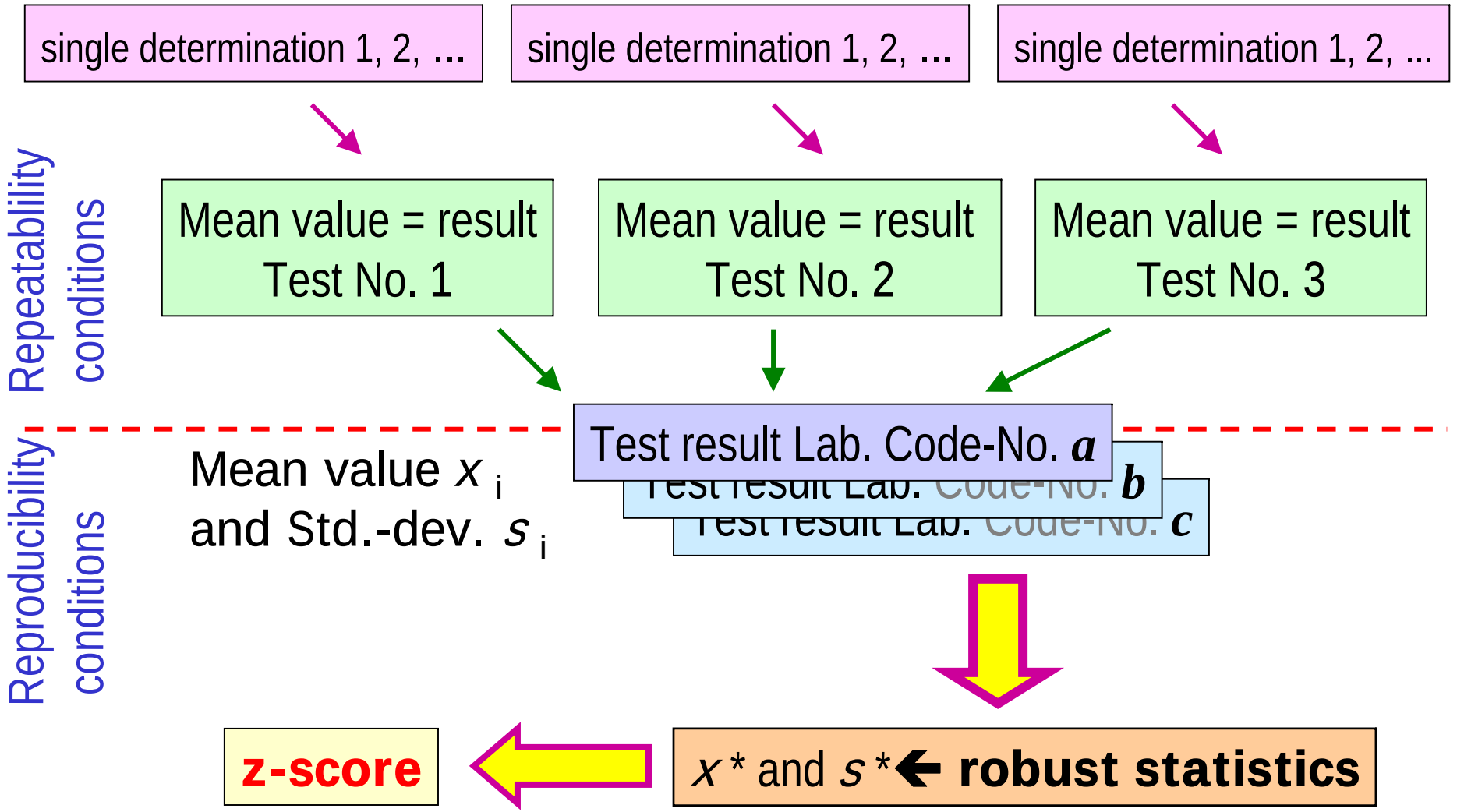
Work flow of the round robin (part 1)



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z - score

- **"z-score"**

x_i .... Test result of the laboratory ***i***

x^* ... robust mean value

s^* ... robust standard deviation

$$z = \frac{(\bar{x}_i - x^*)}{s^*}$$

$\lvert z \rvert \leq 1$	the performance of the laboratory is **very good**
$1 < \lvert z \rvert \leq 2$	the performance of the laboratory is **satisfactory**
$2 < \lvert z \rvert \leq 3$	the performance of the laboratory is **questionable**
$\lvert z \rvert > 3$	the performance of the laboratory is **unsatisfactory**

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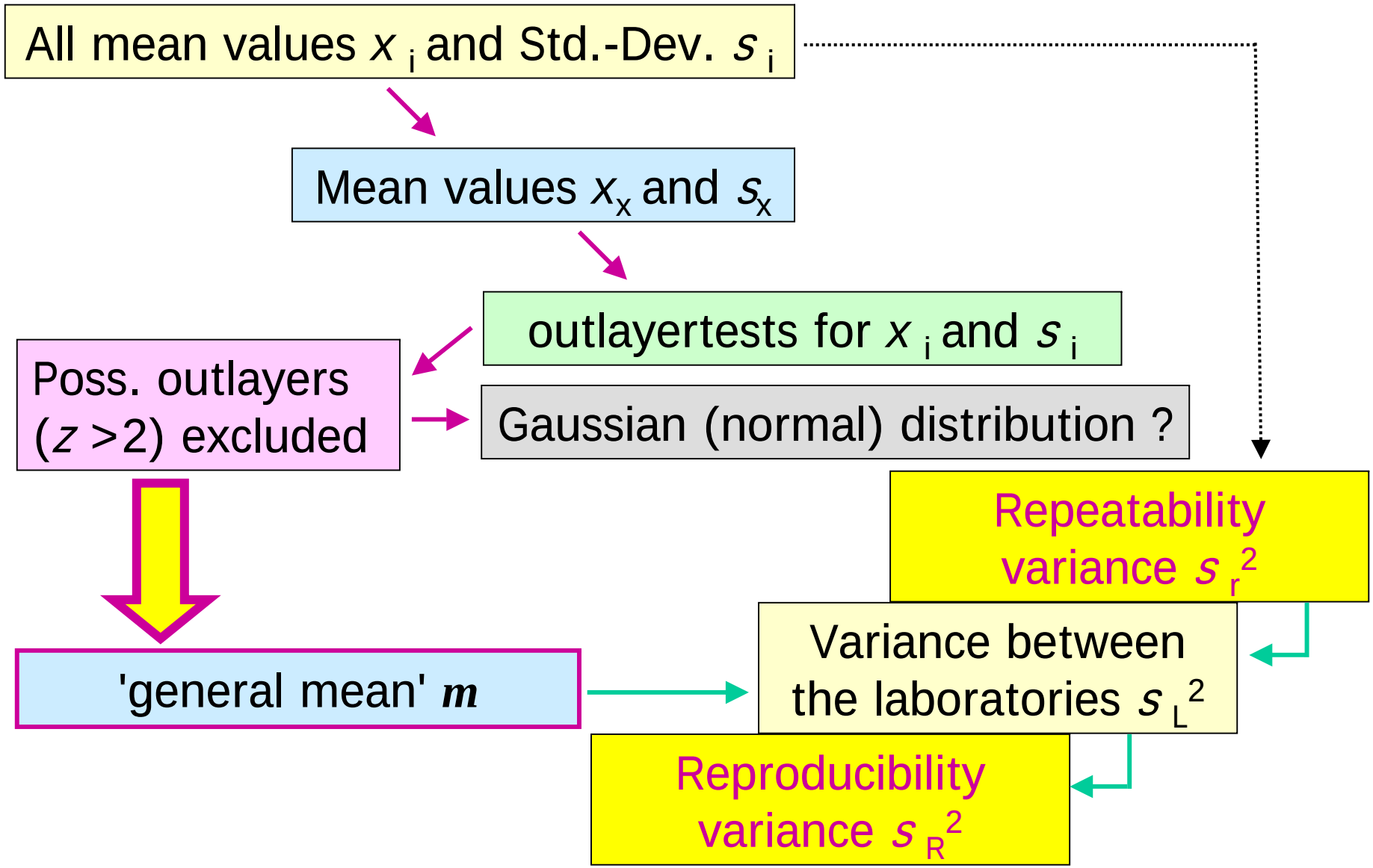
Work flow of the round robin (part 2)



precision of the test method

precision of the test method

- calculation of
  - **Repeatability standard deviation s_r** and **repeatability limit *r*** (same laboratory)
  - **Reproducibility standard deviation s_R** and **reproducibility limit *R*** (between different laboratories, s_r is included in this calculation)

  from test results of
  - **plenty of laboratories**
  - by the use of a standardized test method

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repeatability

- **repeatability**
  - for calcualtion of the **repeatability** the tests have to be repeated within the same laboratory (under repeatability conditions)
  - the smaller the ratio of s_r / s^*, the **fewer replications are necessary** to achieve a reliable robust mean value

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reproducibility

- **reproducibility**
  - can only be calculated by participating in a **round robin test**
  - is high
    - if all laboratories achieve a **comparable repeatability** and
    - the **variance** of the general mean ***m*** is **low**
  - is the crucial factor to provide **confidence in test results**
  - is appropriate to calculate the **expanded measurement uncertainty**

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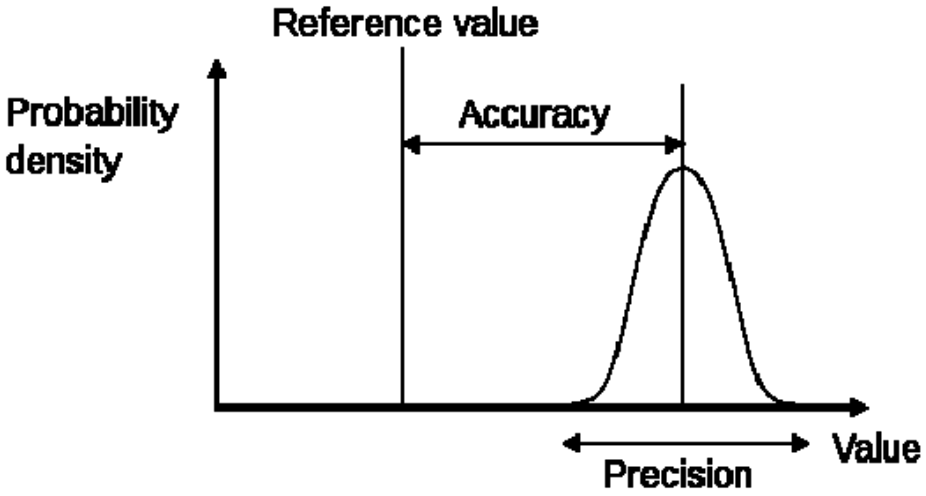
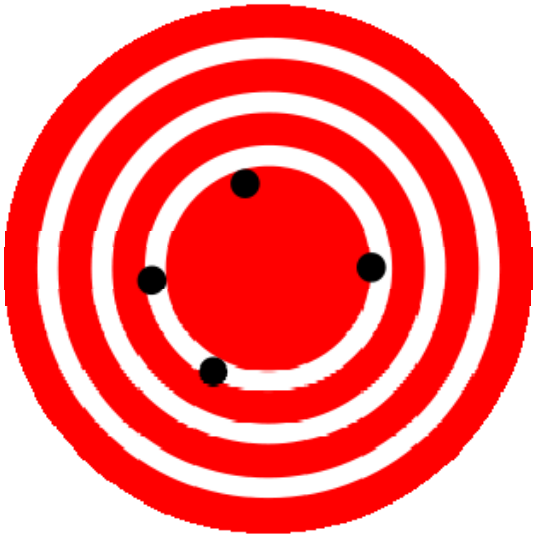
accuracy ⟷ precision



High accuracy, low precision



low accuracy, high precision

expanded measurement uncertainty

- **expanded measurement uncertainty**
  - on basis of the **reproducibility** (a round robin is the only way to obtain this value)
  - acc. ISO/TS 21748:2004 the calculation of the **expanded measurement uncertainty** U is simple and uncomplex:
    ($U = k \cdot s_R$)
    coverage factor k usually $k = 2$
    → level of confidence for U is 95%

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Results (part 1)

Determination of vertical ball behaviour - SS1 - hockeyball - R

EN 12235

Results submitted by participants and **Results of robust statistics**

i.e., individual results x_{ik}

+ number of the test repetitions made by each lab (n_i)
+ within laboratory means (x_i) and standard deviations (s_i)
+ results of tests for outliers

(bottom part of the table)

Number of reporting laboratories p *:	**16**
Number of reported test results $\sum n_i$:	**32**

Lab Code No.	Test results in % — Test replication No. (k) 1	2	3	4	5	6	Statistical evaluation of the submitted test results x_{ik}: n_i	x_i	s_i	Outliers: Cochran	Grubbs	z>2
627	39,18	38,70					2	38,940	0,3394			X
520	39,38	39,46					2	39,420	0,0566		**	X
439	112,54	108,94					2	110,740	2,5456			
136	116,40	115,20					2	115,800	0,8485			
938	117,00	116,20					2	116,600	0,5657			
238	116,42	117,54					2	116,980	0,7920			
565	118,32	120,70					2	119,510	1,6829			
872	121,00	121,20					2	121,100	0,1414			
812	122,68	121,36					2	122,020	0,9334			
99	121,20	126,62					2	123,910	3,8325	*		
362	128,24	127,92					2	128,080	0,2263			
464	129,08	130,26					2	129,670	0,8344			
747	131,50	131,50					2	131,500	0,0000			
279	135,60	136,58					2	136,090	0,6930			
438	135,98	137,62					2	136,800	1,1597			
250	164,22	163,34					2	163,780	0,6223		**	X
178	no results reported											X
66	no results reported											X

Robust average:	x^* =	**122,33**	← **assigned value for the proficiency assessment**
Robust standard deviation for the proficiency assessment:	s^* =	**11,863**	
Number of repeate measurements necessary due to s_r/s^*-ratio:	n' =	1	**OK**
Standard uncertainty of the assigned value:	u_x =	3,70704	**NOT OK**

see page 4 for the meaning of **NOT OK**

** ... statistical outlier (99%) * ... straggler (95%)

X ... z > 2; in this case, x_i is considered to be an outlier and is not taken into account in the test method accuracy check

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Results (part 2)

Additional check of the test method accuracy

Do the input data come from a normal distribution (when outliers found were eliminated) **?** (The results listed below shall be considered as really justified only if the input data come from a normal distribution)			**YES**
General mean $\sum n_i x_{ik} / \sum n_i$	m	**123,75**	**%**
Repeatability variance	s_r^2	2,2408615	
Repeatability standard deviation	s_r	1,49695	**%**
Repeatability coefficient of variation	$CV\%_r$	1,210	**%**
Between-laboratory variance	s_L^2	65,0355949	
Between-laboratory standard deviation	s_L	8,06446	**%**
Between-laboratory coefficient of variation	$CV\%_L$	6,517	**%**
Reproducibility variance s_R^2	$s_r^2 + s_L^2$	67,2764564	
Reproducibility standard deviation	s_R	8,20222	**%**
Reproducibility coefficient of variation	$CV\%_R$	6,628	**%**
Repeatability limit	r	**4,19**	**%**
Relative repeatability limit	r_{rel}	**3,4**	**%**
Reproducibility limit	R	**22,97**	**%**
Relative reproducibility limit	R_{rel}	**18,6**	**%**
Number of participants included in the accuracy evaluation	p	13	
Number of tests included in the accuracy evaluation	$\sum n$	26	

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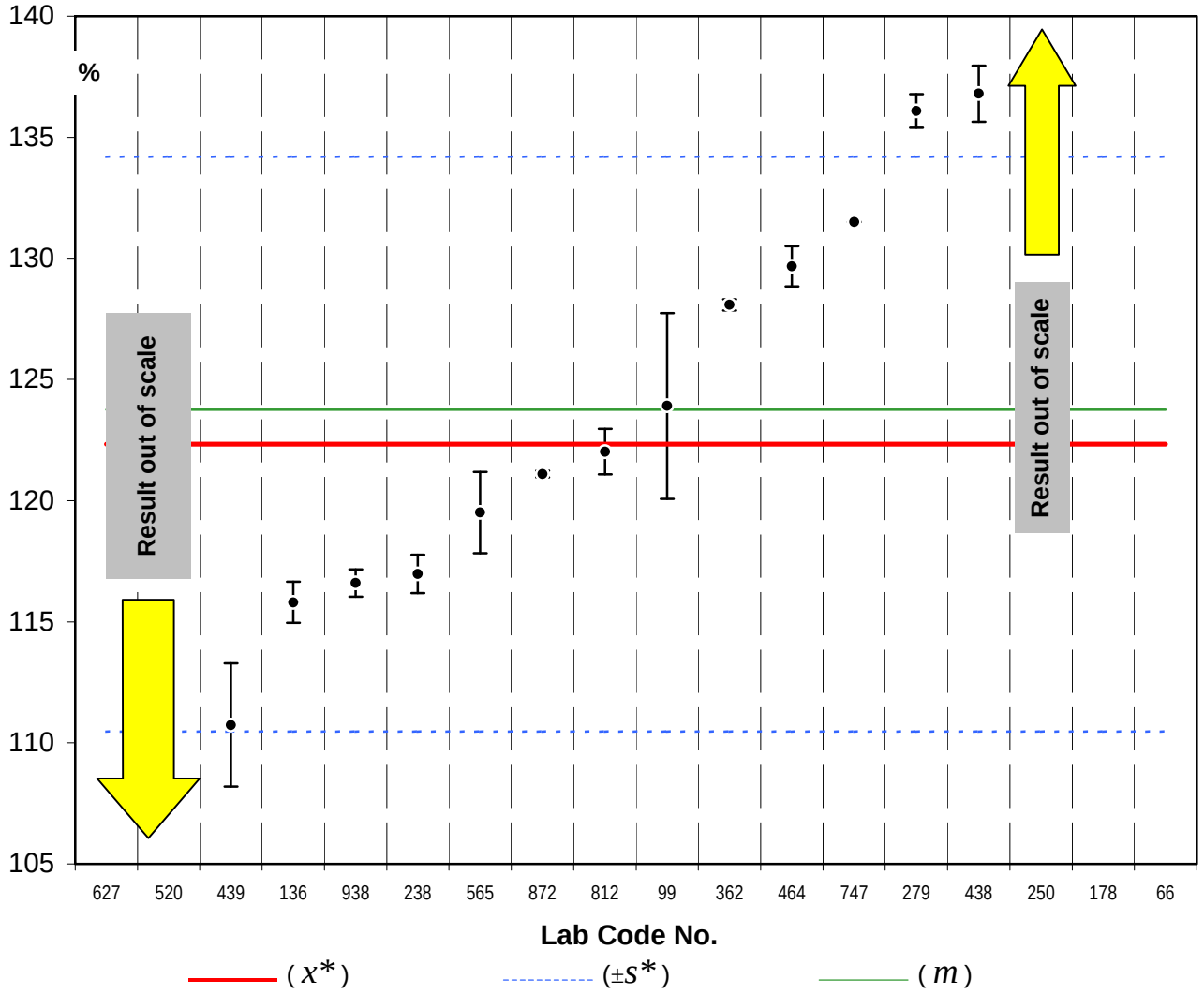
Results (part 3)

Determination of vertical ball behaviour - SS1 - hockeyball - R



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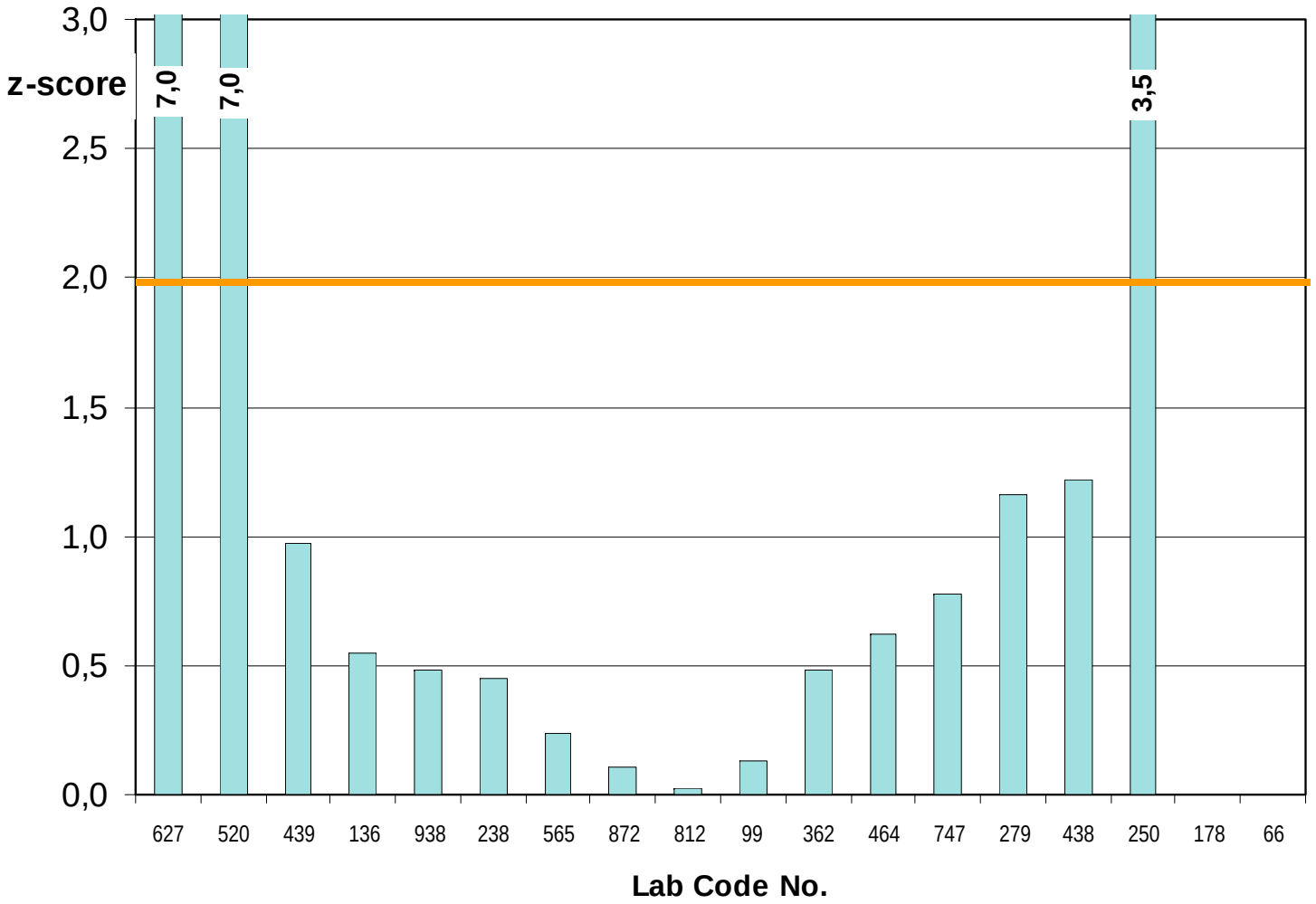
Results (part 4)



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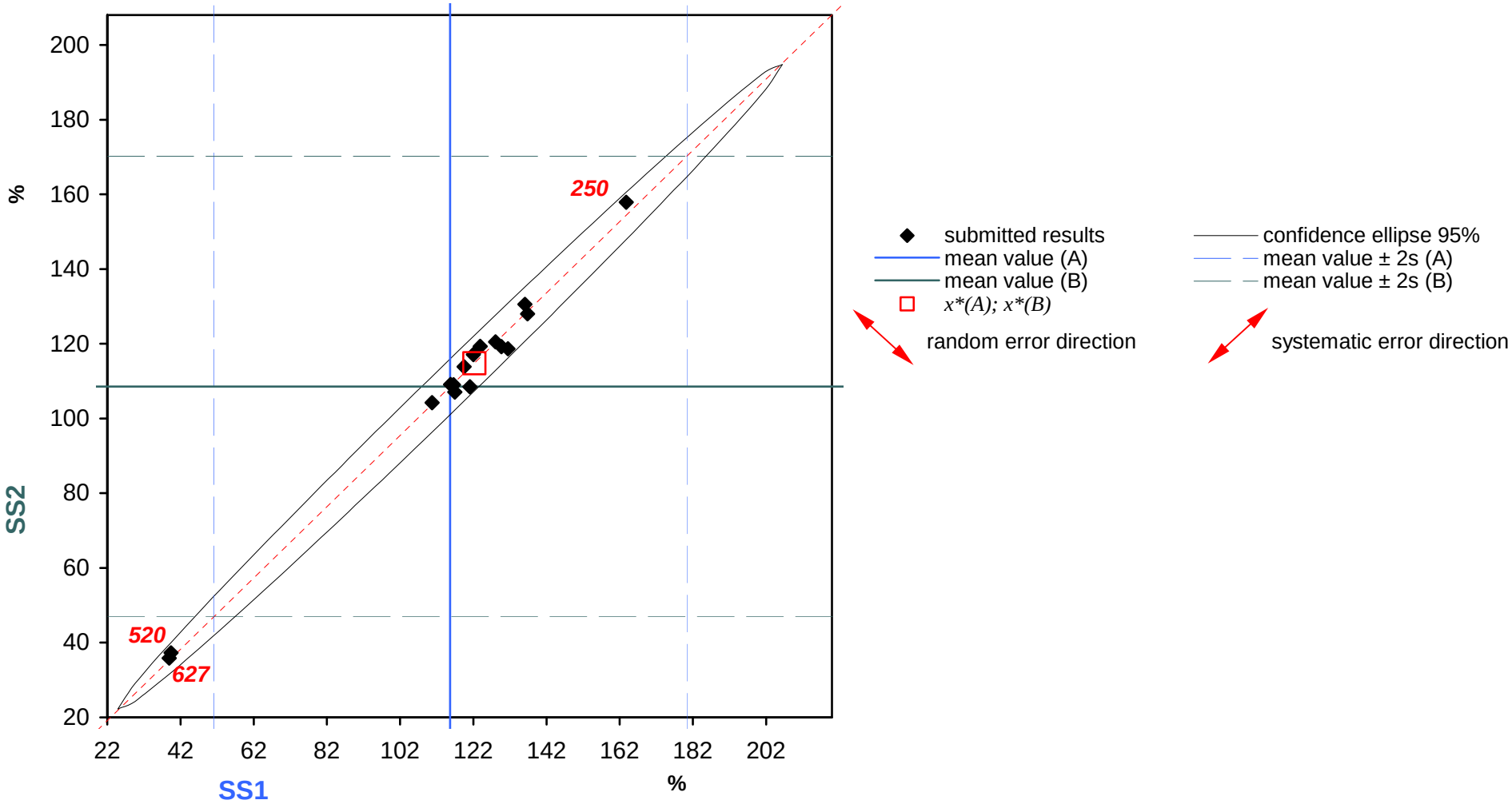
Results (part 5)

Determination of vertical ball behaviour - SS - hockeyball - R



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Results (part 6)

Determination of vertical ball behaviour (EN 12235:2004)

		r_{rel} [%]	R_{rel} [%]
SS1	hockeyball	3,4	18,6
	football	2,2	4,2
	basketball	2,3	5,3
SS2	hockeyball	5,9	20,0
	football	2,6	2,8
	basketball	3,0	5,8
ST3	hockeyball	8,9	22,8
	football	3,3	11,6
	basketball	3,1	18,4
ST4	hockeyball	23,3	41,0
	football	11,0	16,8
	basketball	9,2	24,7

In comparing two test results for the same material obtained by different operators using different equipment on different days, those test result should be judged as not equivalent if they differ by more than the *R*-value.

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conclusions

- benefit of the participation in round robin tests
- maybe changes of conditions (e.g. only one ball)
- additional test methods ???
  - Slip Resistance Scale and Deceleration
  - Dynamic friction
  - Rotational Resistance
- maybe different fees for members of ISSS and non-members

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Thank you for your attention!

ofi – Österreichisches Forschungsinstitut für Chemie und Technik
Franz-Grill Str. 5, Arsenal Objekt 213
A-1030 Wien
Tel.: +43-1-7981601-970
Fax: +43-1-7981601-480