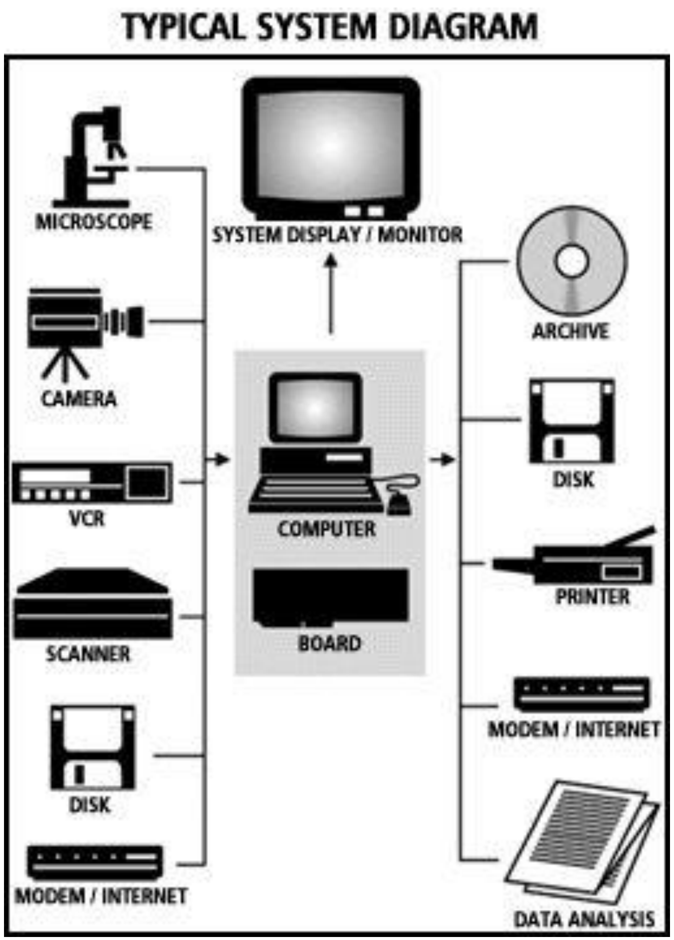
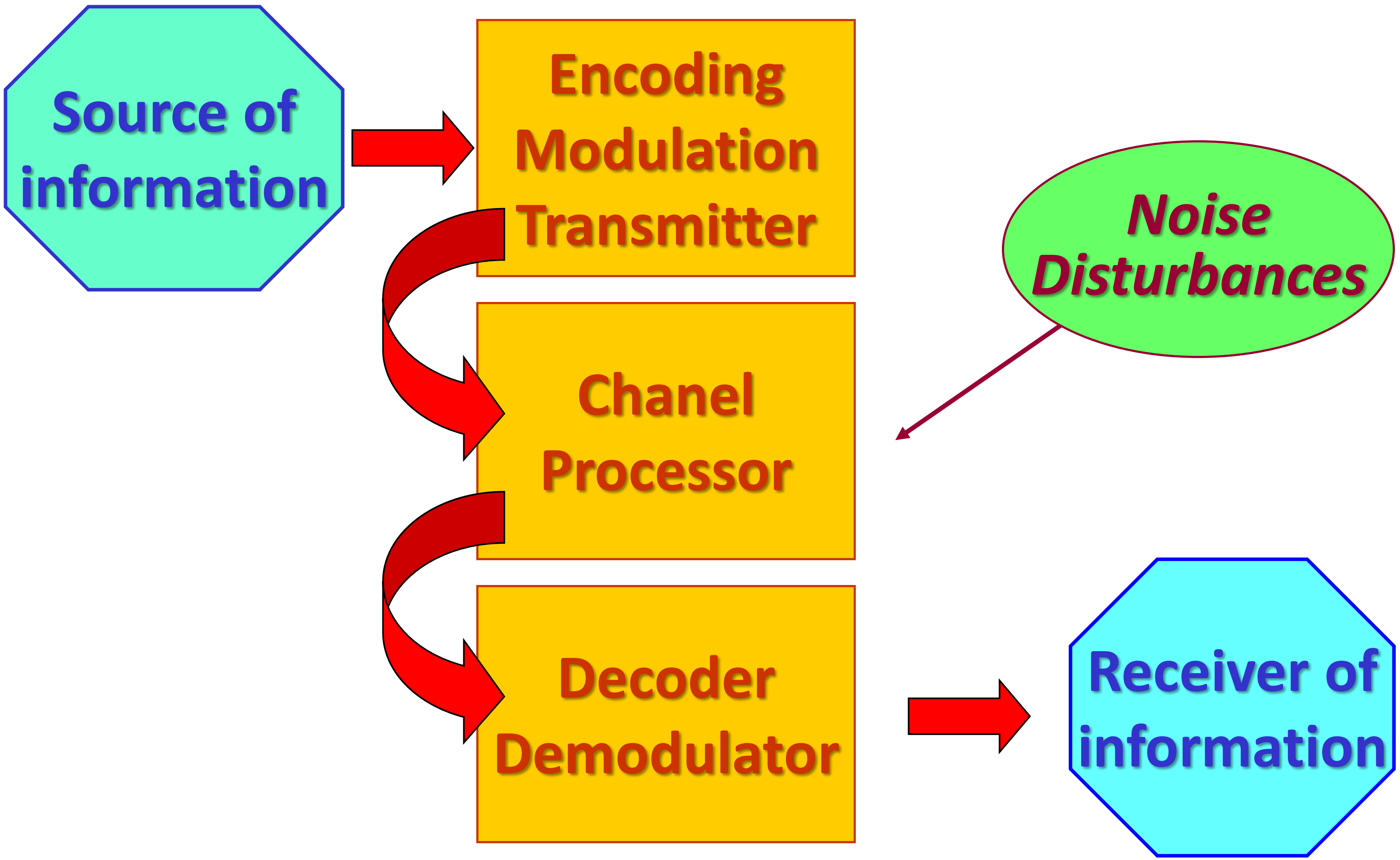
Use of computers in textile laboratories

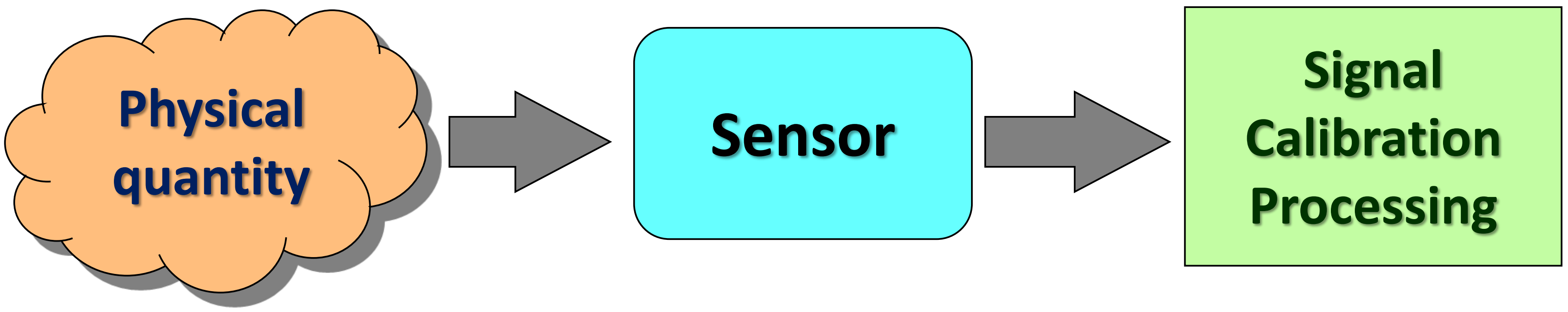


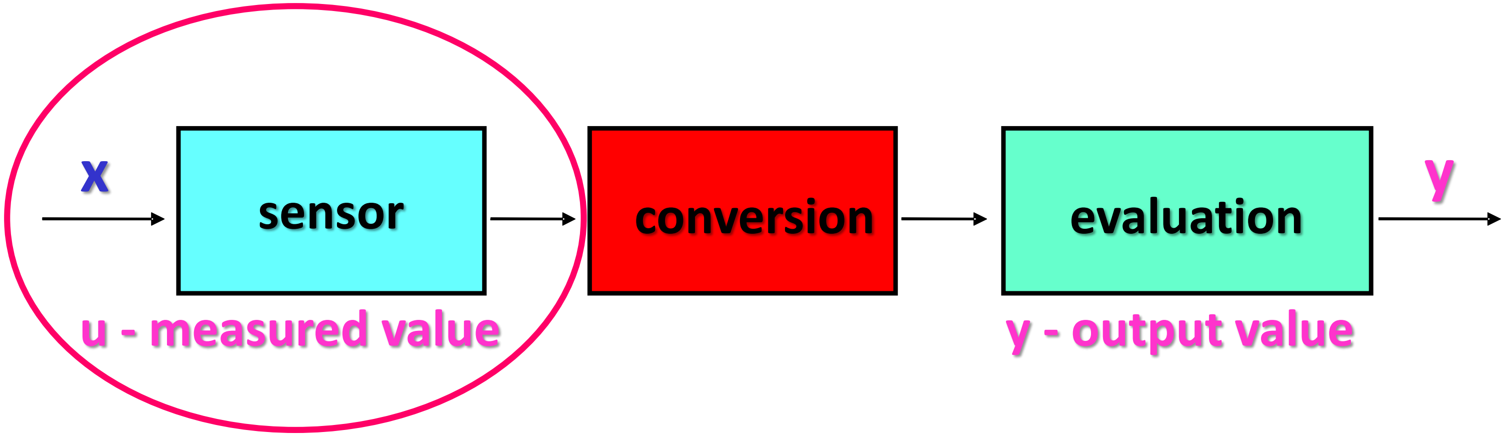
- Sensors
- Data processing
- Analysis and presentation of results

Model of information transfer



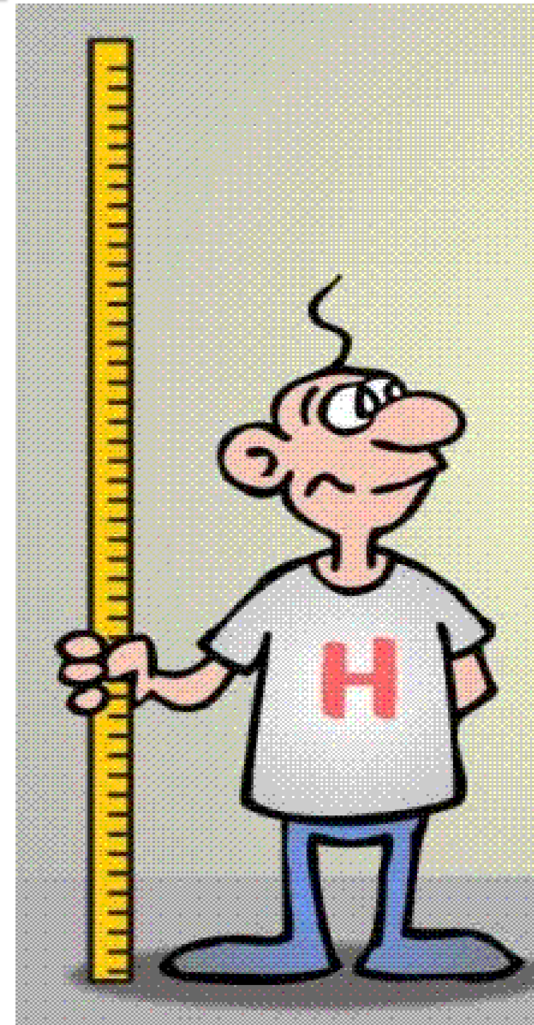
Setting of measuring device



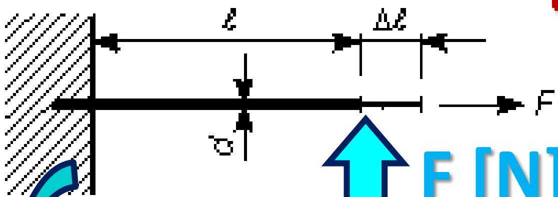


Basic requirements for sensor selection

- **Selection of the type of measured quantities**
  - number of measurements
  - number of measured places
- **Selection of measurement precision**
  - testing method
- **Measurement devices**
  - reliability
  - time demands
  - availability of measurements
  - request on operators
- **Interuptions**
- **Measurement costs**



Example of measuring system setting



F [N]

Tensile load

F [N]

Resistance of conductor

$R = \rho\, l / S$

ρ - resistivity of material

deformation

Δl [mm]

$$Range = x_{max} - x_{min}$$

$$\frac{\Delta R}{R} = k \cdot \frac{\Delta l}{l} = k \cdot \varepsilon$$

$$\delta_{0,R} = {}^{\Delta_0}/_{Range}$$

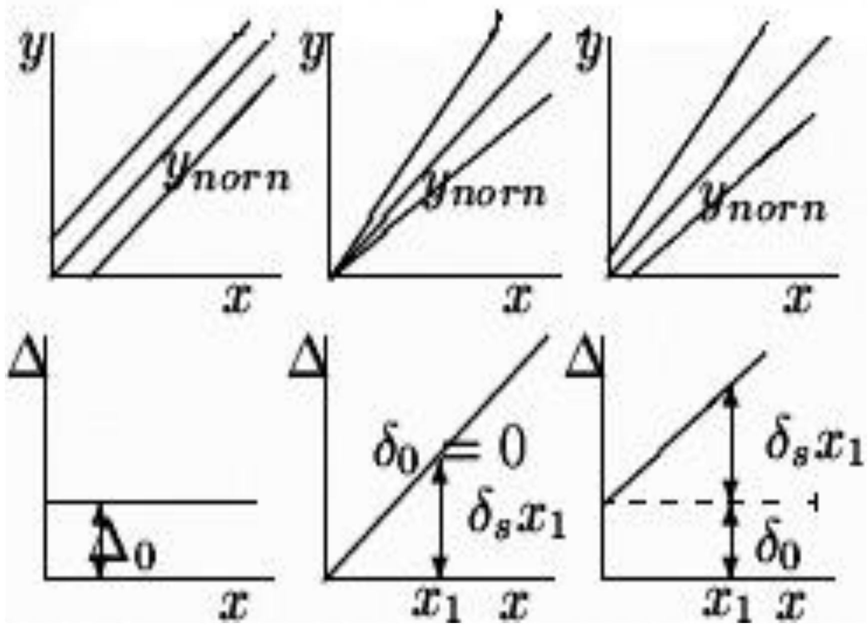
Elektrical resistance R [Ω]

k coefficient of deformation sensitivity

Strength σ [Pa]

Measurement errors

- Average error of measu-rement device σ_{inst}
- Variability of material σ_M
- Average measurement error σ_V
- Non-correlated values



$$\sigma_V = \sqrt{\sigma_{inst}^2 + \sigma_M^2}$$

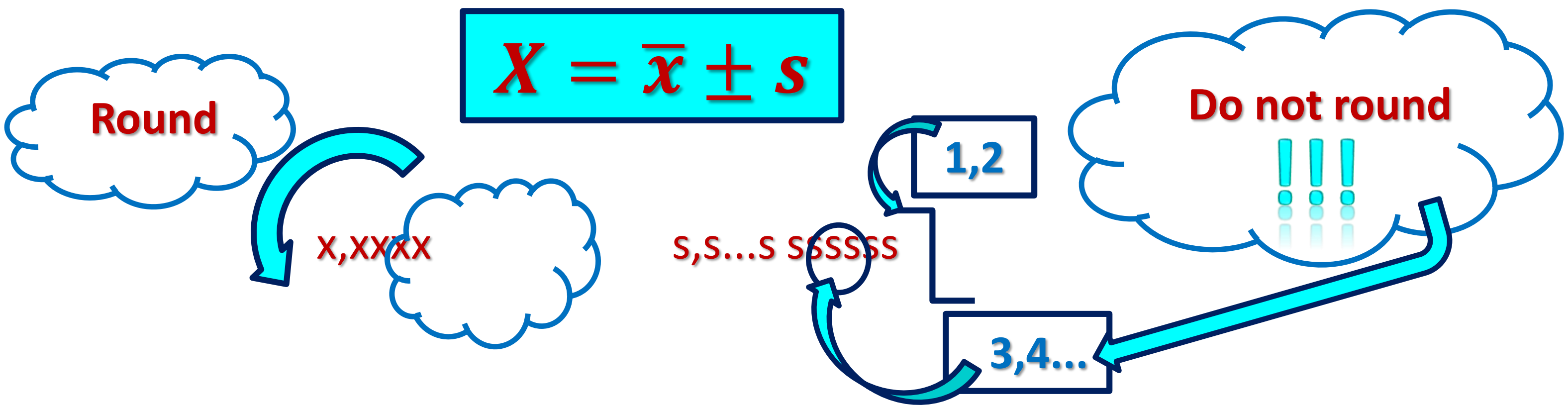
- We usually choose a device so accurate that the error of the measurement results σ_V only!!! **corresponds to variability of the measured material!!!**

Rounding of measurement values

MEASURED VALUES =

Resulting values ± Standard deviation

$$X = \overline{x} \pm s$$



- **Example: Mass of 100 m of yarn is 2.54689 g**
  - Error of scale A = 528 mg ⇒ Value **A = 2.5 ± 0.5 g**
  - Error of scale B = 248 mg ⇒ Value **B = 2.55 ± 0.24 g**

Data processing I.

- Estimation of mean value (average, modus, median)

Average $$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \quad [\ldots\ldots]$$

Modus $\hat{x}$ mostly repeated value

Median $$\tilde{x} = x_{(k)}$$ *where* $$k = \frac{n}{2}$$ *for odd* n

$$\tilde{x} = \frac{x_{(k)} + x_{(k+1)}}{2}$$ *where* $$k = \frac{n+1}{2}$$ *for even* n

Data processing II

- Estimation of variability (variance, standard deviation)
- *Variance s^2 and standard deviation s*

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{x})^2 \quad [\ldots^2]$$

$$s = \sqrt{s^2} \quad [\ldots]$$

- Coeff. of variance $v = \frac{s}{\overline{x}} \cdot 10^2 [\%]$

Confidence interval ⇒ CI

- Lower limit L_D
- Upper limit L_H

$$L_D = \overline{x} - t_{\alpha(n-1)} \cdot {s}/{\sqrt{n}} \quad [\ldots]$$

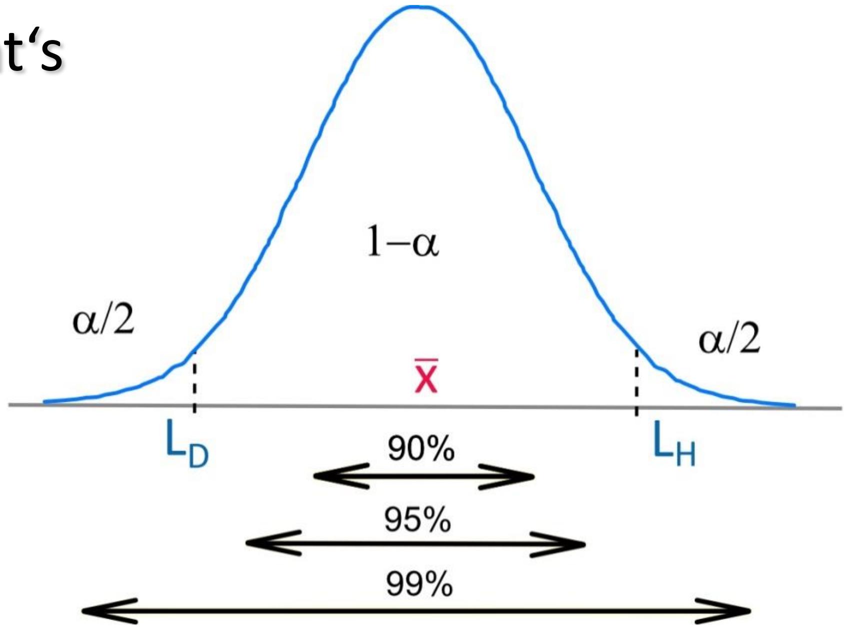
$$L_H = \overline{x} + t_{\alpha(n-1)} \cdot {s}/{\sqrt{n}} \quad [\ldots]$$

- $t_{\alpha(n-1)}$ ⇒ kvantil of Student's selective distribution
- *For* $n \cong \infty$ *, and* $\alpha = 0,95$

$t_{\alpha(n-1)} = 1,96$

E.g. CI for linear density:

$CI_T = \langle 24,1; 25,1 \rangle \; tex$



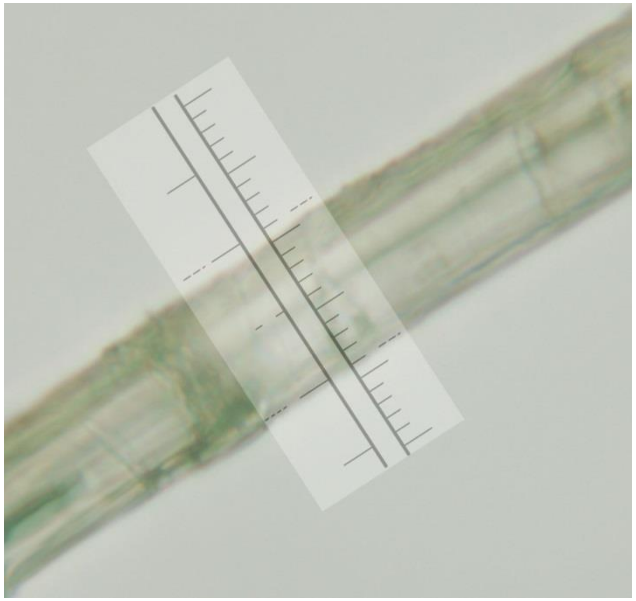
Large data set

- **categorization of data j, (x_j), j = 1, 2, 3, ….k,**
  $\Rightarrow$ set of categories
  - Sign of category **x_j**
  - Number of measurements in category **n_j**
  - Number of all measurements **n**
  - Frequency function **f_j**

$$n = \sum n_j$$

$$f_j = \frac{n_j}{n}$$

j	x_{jd} - x_{jh} [µm]	x_j [µm]	number of measurement	n_j
1	11 - 13	12	𝍸 𝍸	
2	13 - 15	14	𝍸 𝍸 𝍷𝍷𝍷	
3	15 - 17	16	𝍸 𝍸 𝍸 𝍸	
4	17 - 19	18	𝍸 𝍸 𝍸 𝍸 𝍸 𝍷𝍷	
5	19 - 21	20	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	



Large data set > 40

- Setting of category range
- Extent of category
- Number of categories
- Calculation of mean and variance
- Confidence interval

$$R = x_{max} - x_{min}$$

$$\Delta x = 0,08 \cdot R$$

$$10 \le k \le 20$$

$$\overline{x} = \frac{1}{n}\sum_{j=1}^{k} x_j \cdot n_j$$

$$s^2 = \frac{1}{n}\sum_{j=1}^{k} \left(x_j - \overline{x}\right)^2 \cdot n_j$$

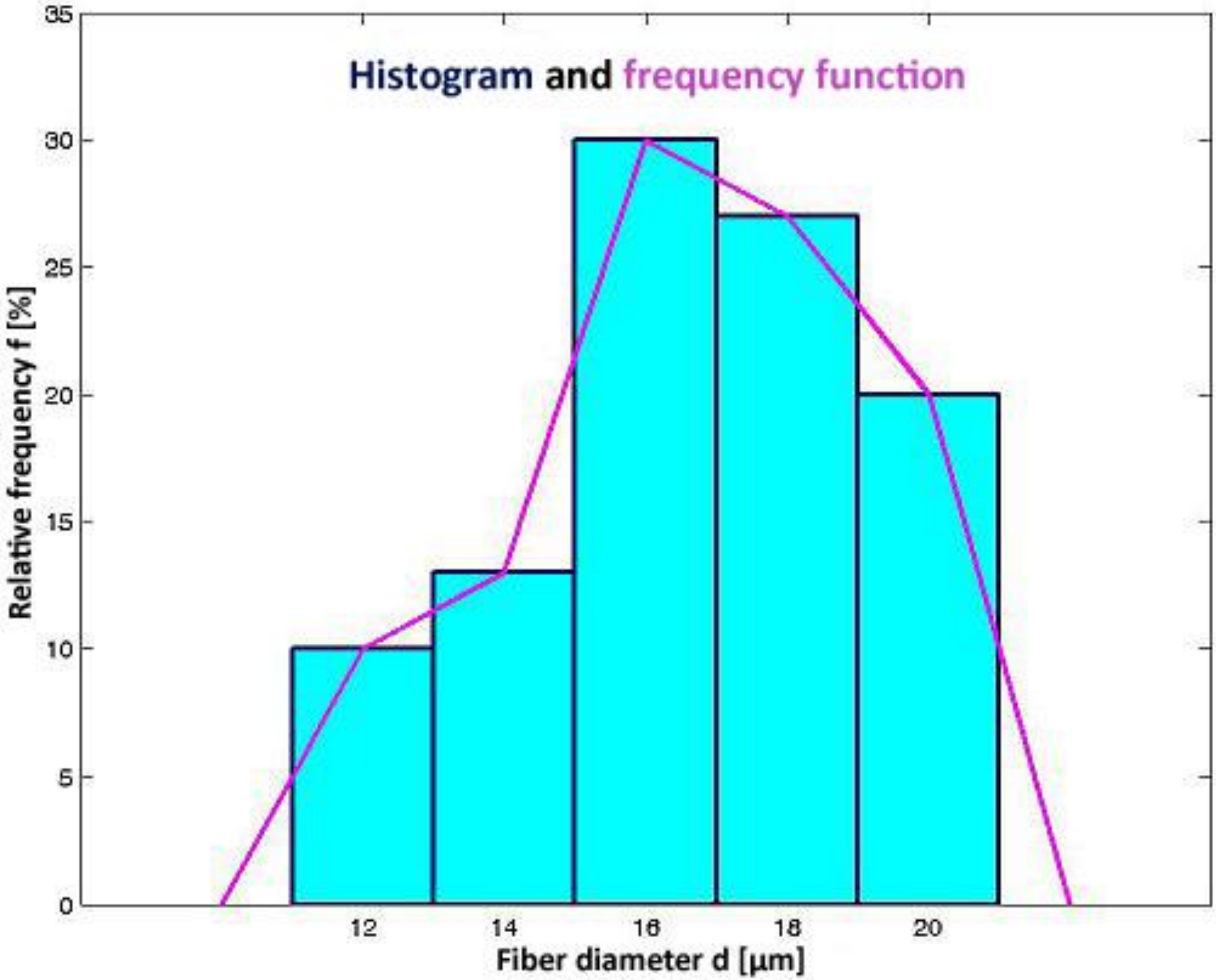
$$s = \sqrt{s^2}$$

$$CI_p = \overline{x} \pm t_{\alpha(n-1)} \frac{s}{\sqrt{n}} \ [unit]$$

Histogram and frequency function

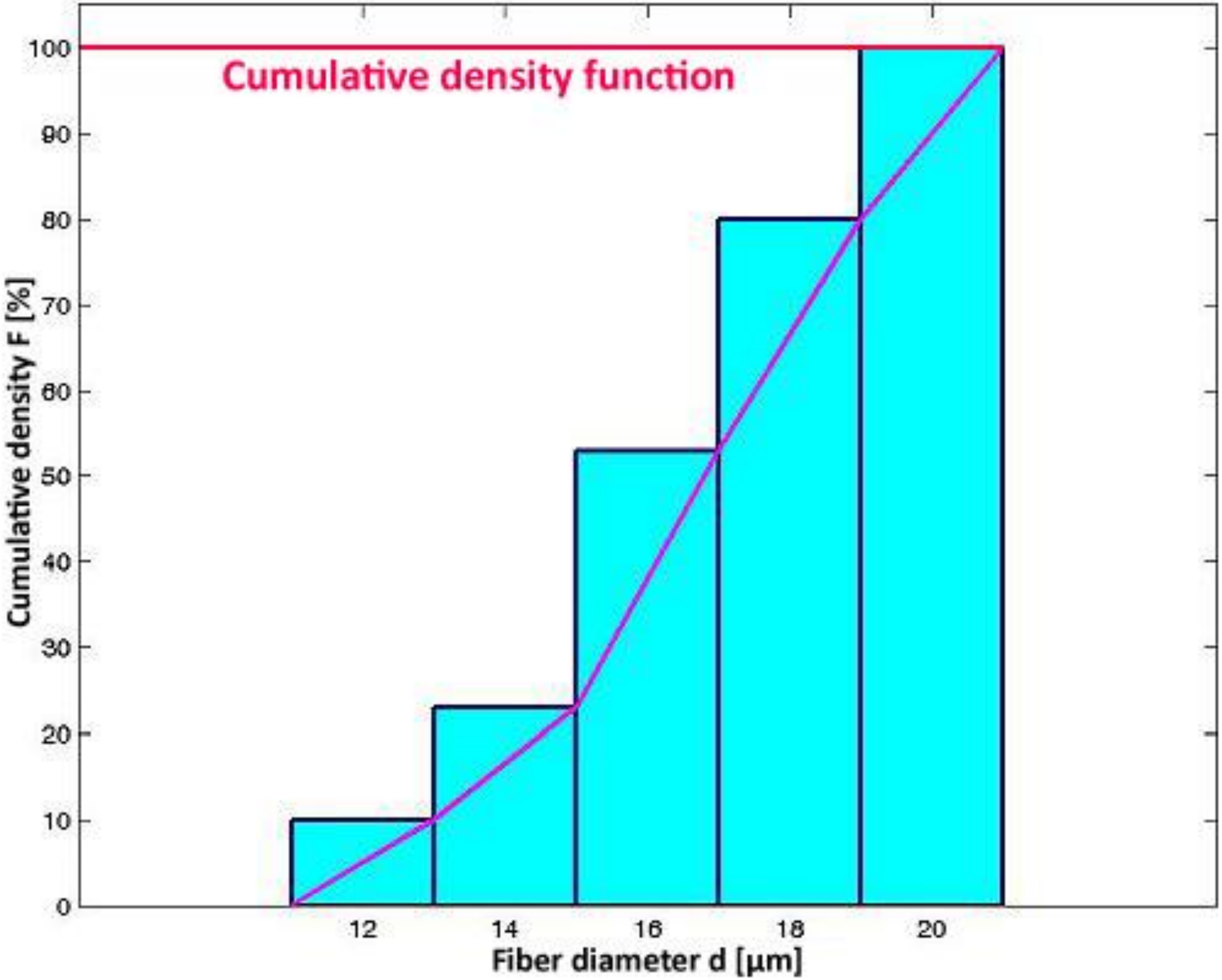
$$f_j = \frac{n_j}{n} \cdot 100\ [\%] \quad n = \sum_{j=1}^{k} n_j$$

j	d_{jd} - d_{jh} [μm]	d_j [μm]	number of measurements	n_j	f_j [%]
1	11-13	12	卌 卌	10	**10**
2	13-15	14	卌 卌 |||	13	**13**
3	15-17	16	卌 卌 卌 卌 卌 卌	30	**30**
4	17-19	18	卌 卌 卌 卌 卌 ||	27	**27**
5	19-21	20	卌 卌 卌 卌	20	**20**
			Σ...	n=100	100%


Histogram and frequency function
35
30
25
20
15
10
5
0
Relative frequency f [%]
12
14
16
18
20
Fiber diameter d [μm]

Histogram and cumulative density function

j	d_{jd} - d_{jh} [µm]	d_j [µm]	number of measurements	n_j	f_j [%]	**F_j [%]**
1	11-13	12	𝍸 𝍸	10	10	**10**
2	13-15	14	𝍸 𝍸 |||	13	13	**23**
3	15-17	16	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	30	30	**53**
4	17-19	18	𝍸 𝍸 𝍸 𝍸 𝍸 ||	27	27	**80**
5	19-21	20	𝍸 𝍸 𝍸 𝍸	20	20	**100**


Cumulative density function
Cumulative density F [%]
0
10
20
30
40
50
60
70
80
90
100
12
14
16
18
20
Fiber diameter d [μm]