# CAN WE BE SCIENTISTS WITHOUT THE RULES?

Few words about practical, socio-economical, and ethical implications of good scientific practice.

Malgorzata Kopycinska-Müller, Christian Wunderlich

# In science we trust….



*In Fauci We Trust by PrankyArt*

*https://oxsci.org/public-trust-in-science-sink-or-swim/*



intern



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# Is “trust” the correct word?

## trust

/trʌst/

See definitions in:

All | Law | Commerce · *Dated*

*noun*

noun: **trust**

1. firm belief in the reliability, truth, or ability of someone or something.
   "relations have to be built on trust"

   Similar: confidence | belief | faith | freedom from suspicion/doubt | sureness | certainty | certitude | assurance | conviction | credence | reliance

   Opposite: distrust | mistrust | scepticism

   - acceptance of the truth of a statement without evidence or investigation.
     "I used only primary sources, **taking** nothing **on trust**"
   - the state of being responsible for someone or something.
     "a man in a position of trust"

     Similar: responsibility | duty | obligation
   - LITERARY
     a person or duty for which one has responsibility.
     plural noun: **trusts**
     "rulership is a trust from God"

*Trust (verb) to hope confidently; to believe*

## knowledge

/ˈnɒlɪdʒ/

See definitions in:

All | Computing | Philosophy | Sex

*noun*

noun: **knowledge**; plural noun: **knowledges**

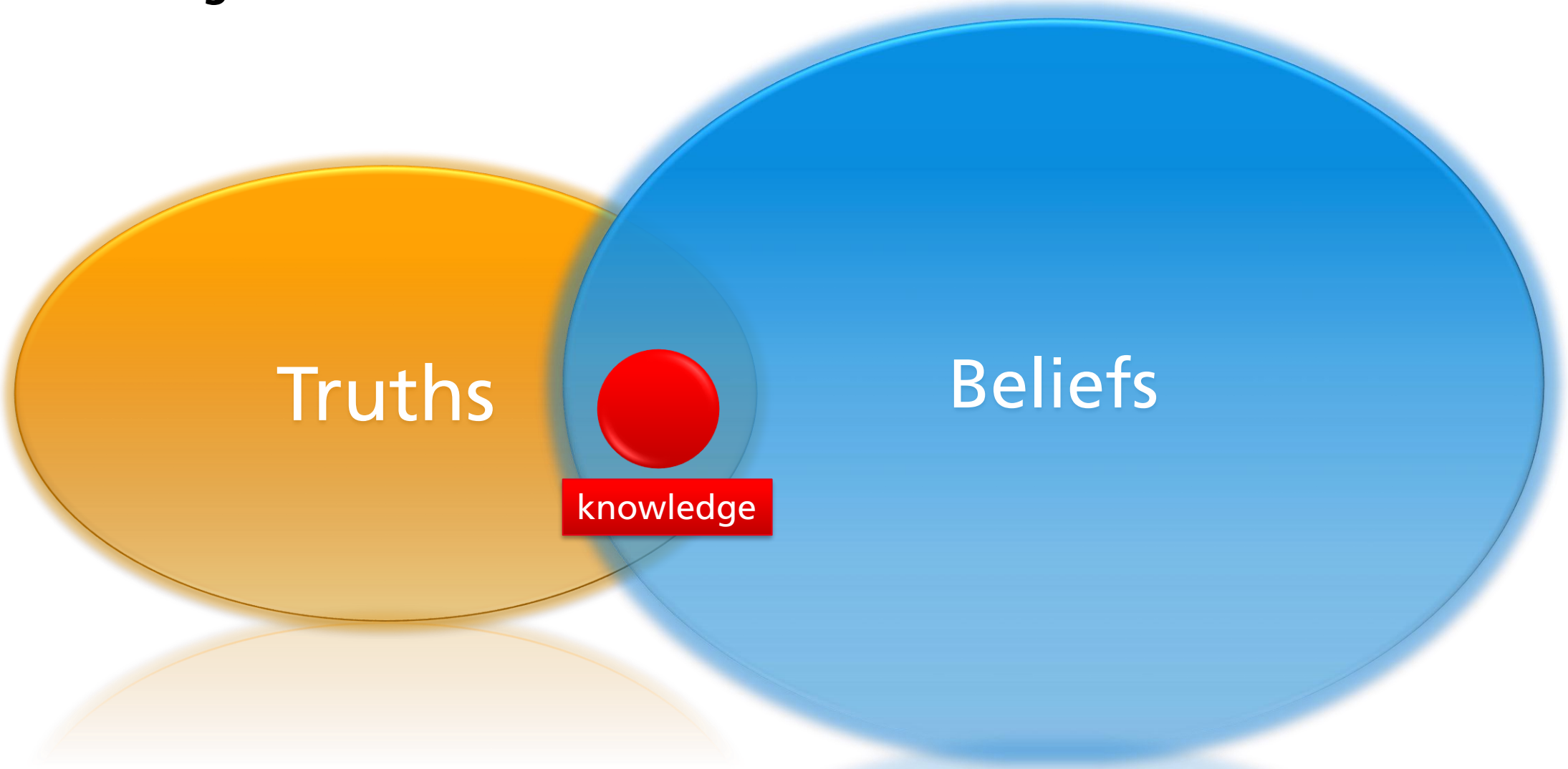
1. facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject.
   "a thirst for knowledge"

   Similar: understanding | comprehension | grasp | grip | command | mastery | apprehension | expertise | skill | proficiency | expertness | accomplishment | adeptness | capacity | capability | savoir faire | know-how | learning | erudition | education | scholarship | letters | schooling | science | wisdom | enlightenment | philosophy | familiarity with | acquaintance with | conversance with | intimacy with | information | facts | data | intelligence | news | reports | lore | info | low-down | gen

   Opposite: ignorance | illiteracy

   - the sum of what is known.
     "the transmission of knowledge"
   - information held on a computer system.
   - PHILOSOPHY
     true, justified belief; certain understanding, as opposed to opinion.
2. awareness or familiarity gained by experience of a fact or situation.
   "the programme had been developed **without his knowledge**"

# “Knowledge is a subset of all true beliefs”



# It is all about verification and validation


Our skills and knowledge

Our work

**verification**

/ˌvɛrɪfɪˈkeɪʃ(ə)n/

*noun*

the process of establishing the truth, accuracy, or validity of something.
"the verification of official documents"

Similar: confirmation substantiation corroboration attestation affirmation validation authentication endorsement accreditation ratification establishment certification evidence proof support witness testament documentation

**validation**

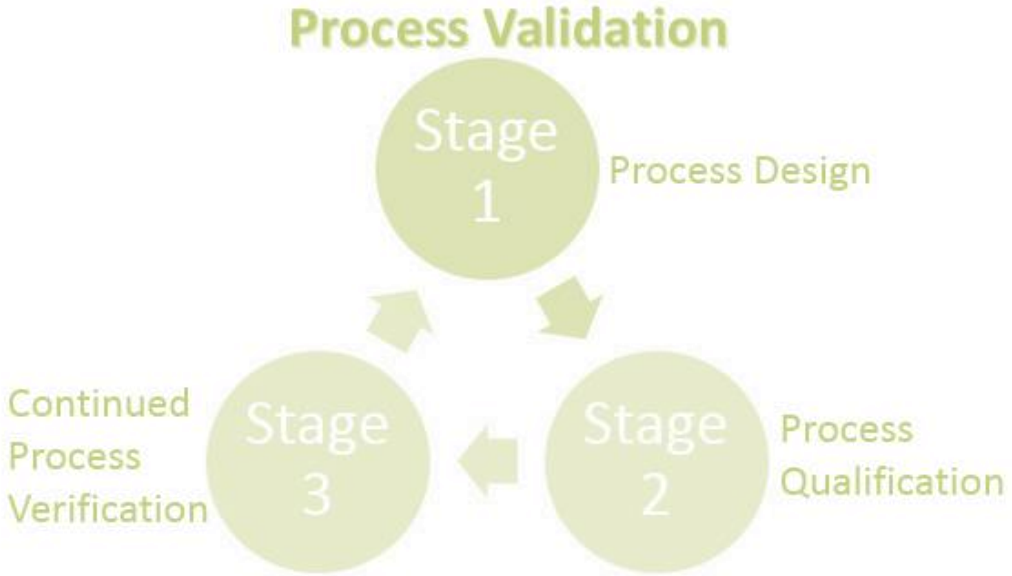
/valɪˈdeɪʃ(ə)n/

*noun*

noun: **validation**; plural noun: **validations**

the action of checking or proving the validity or accuracy of something.
"the technique requires validation in controlled trials"

- the action of making or declaring something legally or officially acceptable.
  "new courses, subject to validation, include an MSc in Urban Forestry"
- recognition or affirmation that a person or their feelings or opinions are valid or worthwhile.
  "they have exaggerated needs for acceptance and validation"




https://smartpartnersng.com/

www.emersonautomationexperts.com



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# Verification of education, experience, and skills – a record of life long education

University degree (college)

(graduation certificate)


Work experience + reference


List of achievements:

Patents

Papers

Awards

…..

*www.colorado.edu/registrar/alumni/diplomas/cediploma* *www.slideteam.net* *www.kindpng.com*





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# Good scientific praxis

Rules for validation and verification of research

- Funding: process of acquisition and use of it
- Experimental work: data acquisition process
- Data: analysis, understanding, presentation
- Documentation: description of data acquisition, data analysis, data storage
- Publishing: acknowledgment of contribution
- Learning to talk about mistakes

# Money is the root of all evil, or let us talk about funding

https://nanotempertech.com/wp-content/uploads/2020/04/Funding-Featured-Image.png

# Noble goal: funds go to the best groups with best ideas

Participants

- No collaboration with the reviewers
- Must deliver original idea and innovative solution*
- Experience in the administrative process required

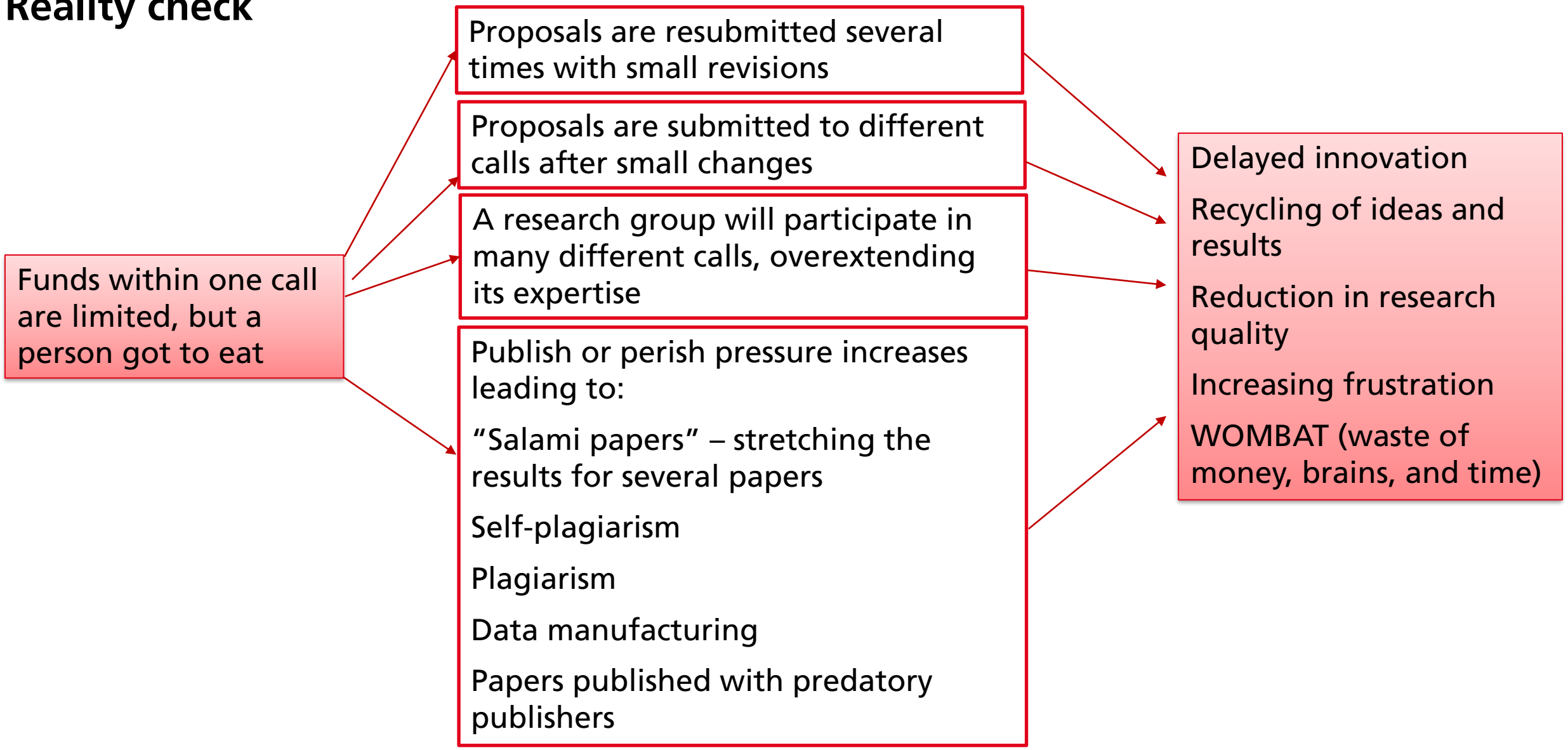
Reviewers

- Experts in the field
- Expertise measured in numbers of published papers, awarded proposals, and projects completed

- No competition or collaboration with the call participants
- Must be able to discern between a BS and a really good idea
- Realistic approach and healthy judgment skills required
- Work is on voluntary basis
- Time has to be sufficient

*spoiler: if I know how to solve a problem I don't have to research it

# Reality check

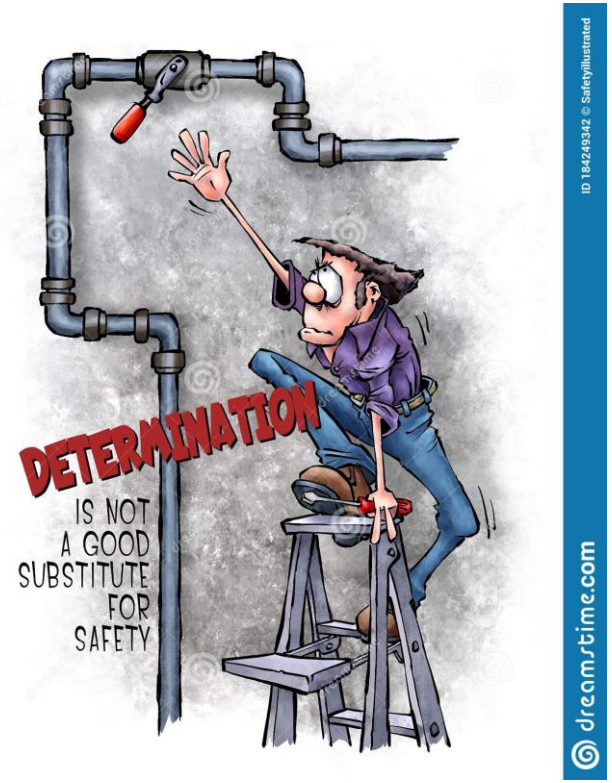


# Visualization for getting funding ….

Research with strong foundation and long tradition

New frontiers of high risk demanding people with training, experience, equipment and dedication

Insufficient knowledge leading to overreaching




www.wernerco.com/us/support/training/safety-tips

www.masterclass.com/articles/top-rope-climbing-guide#what-is-toprope-climbing

www.dreamstime.com/illustration/ladder-safety.html



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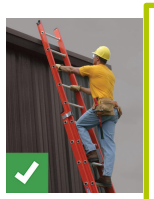
# Different scenarios



Established reputation in the field

Solid research documented in publications

Experience

Applies for funding in the established fields

Lower risks from scientific point of view

Offers improvements

Gains new insights

Established reputation in different fields

Exceptional research documented in publications

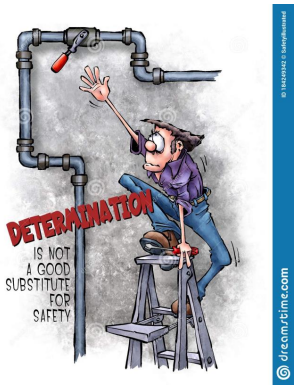
Experience

Applies for funding to establish new fields

New theories established or new theories tested

High risk !

Discoveries and innovation




Someone who will risk a lot to get funding:

- Data fabrication
- Overextension of resources
- Promising not achievable goals

# “Inappropriate” use of project money …..

## “Renowned psychologist suspected of fraud”

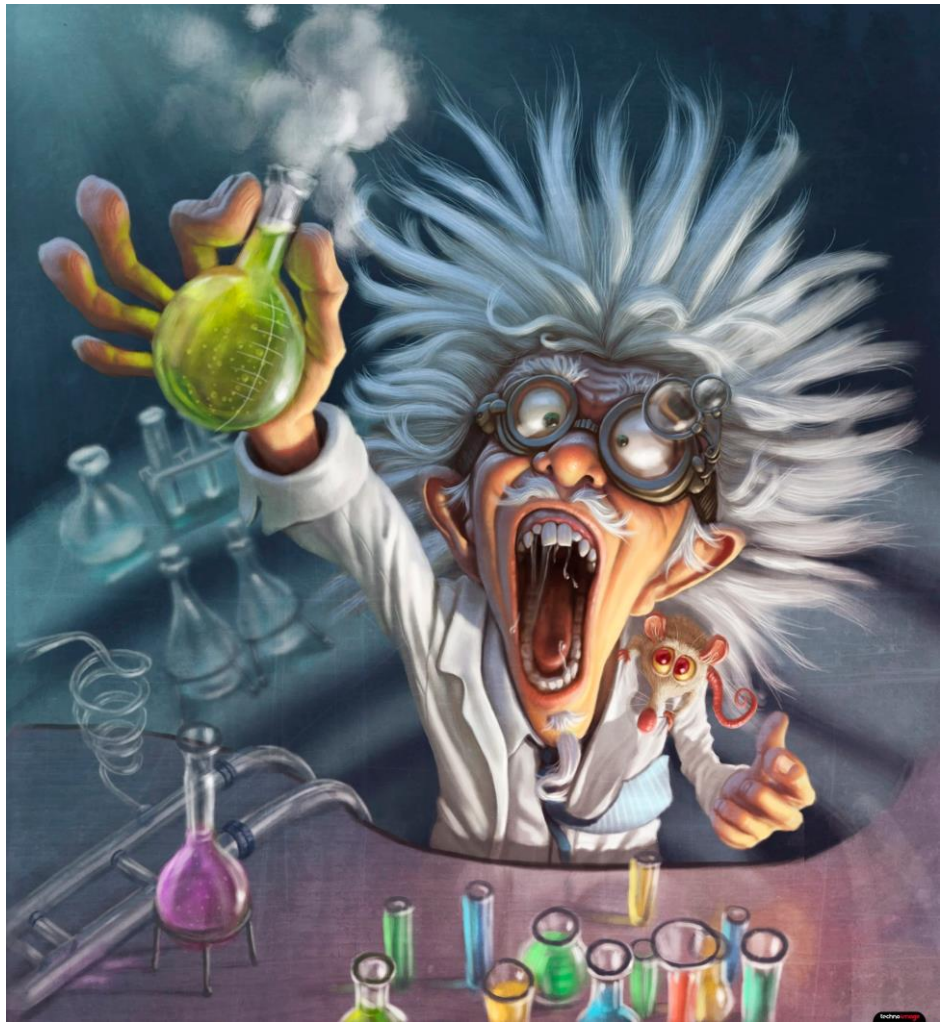
*Hans-Ulrich Wittchen is alleged to have falsified data for the most important psychiatric study of recent decades and thus rendered it worthless. Evidence of privately used research funds raises further questions.*

*By Marc Scheloske*

- Bribery
- Unethical behavior
- Nepotism
- Bullying
- Obstruction of investigation


*https://www.sueddeutsche.de/wissen/wittchen-faelschung-tu-dresden-ppp-studie-psychiatrie-1.5226427*

# Experimental work and data



https://evil.fandom.com/wiki/Mad_Science, Added by B1bl1kal Posted in Mad Science

# Let us talk about data

Step 1:

A hypothesis is formulated based on few data (or extrapolation of existing data but in different field); we have an idea how something could work but the evidence is limited or missing

Step 2:

We want to collect the data to test our hypothesis (never ever only to confirm it!) and we formulate a plan involving the equipment and measurement series

Step 3:

We analyze the data (we interrogate them long enough to get all the information there is (not only the one we want to hear!)

Step 4:

Draw conclusions from your data analysis and compare them against your hypothesis. Remember: there is no BAD DATA!

Step 5a: The data confirms your hypothesis .

“positive” result

Step 5b: The data do not confirm your hypothesis.

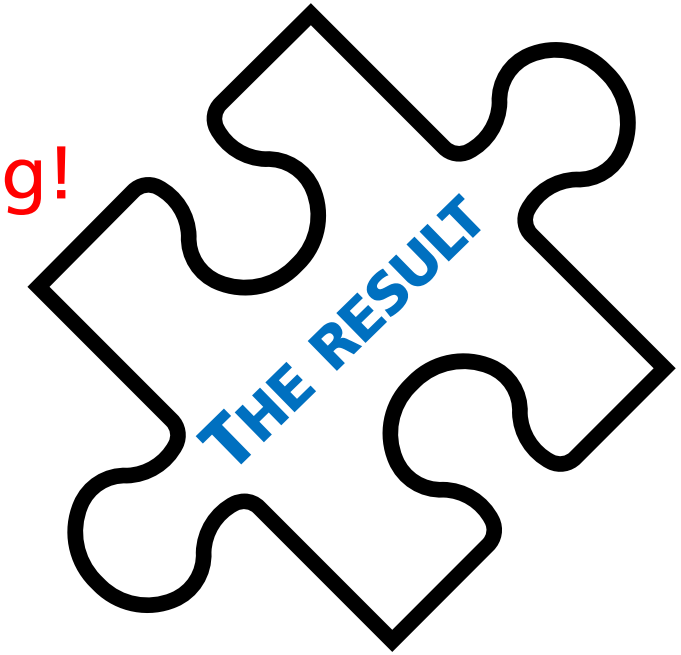
“negative” result

# #nofilter or the obsession with perfection
# On the obsessive culture of positive results

## “Positive” results = Success!

“Negative” result = Failure!

Both statements are wrong!




https://sciencenordic.com/basic-research-basic-research-crisis-denmark/scientists-there-is-too-much-focus-on-positive-results/1442690

# Selective vision of scientists and scientific journals

*When scientists publish only positive results in scientific journals, it can skew our picture of the world.*

*Johanne Uhrenholt Kusnitzoff and Charlotte Price Persson*

> *"If you want to form a conclusion based on an experiment, it is a basic rule in science that you include all data—both positive and negative"*

Silas Boye Nissen published an article showing the importance of publishing „negative data" so we can have an realistic picture of the problem.

> *"Our model shows that if we want to avoid making false assumptions about scientific facts, then we need to publish at least 20 per cent of all negative results that are produced in every field of scientific research," says Nissen.*
>
> *This number could be even higher in some cases, he says. "The number will vary depending on parameters such as field of research and the number of the positive results that are in fact false. So in some fields, we may need to set the minimum publication level for negative results at 40 per cent."*

https://sciencenordic.com/basic-research-basic-research-crisis-denmark/scientists-there-is-too-much-focus-on-positive-results/1442690

https://elifesciences.org/articles/21451

# Selective vision of scientists and scientific journals

*"An American study of new medicines showed that there's only ten per cent chance of getting a negative result published, while nearly all positive results come out," says Nissen.*

*He also points to another study that showed the number of positive results published in the journal Nature rose by 22 per cent between 1990 and 2007.*

*"A good example is a new antidepressant treatment being tested in the USA in 14 clinical trials. Seven of them gave positive results and all of them were published. The rest of the studies gave negative results, with no effect, but only two of these were published," he says and points to a 2008 study in The New England Journal of Medicine.*

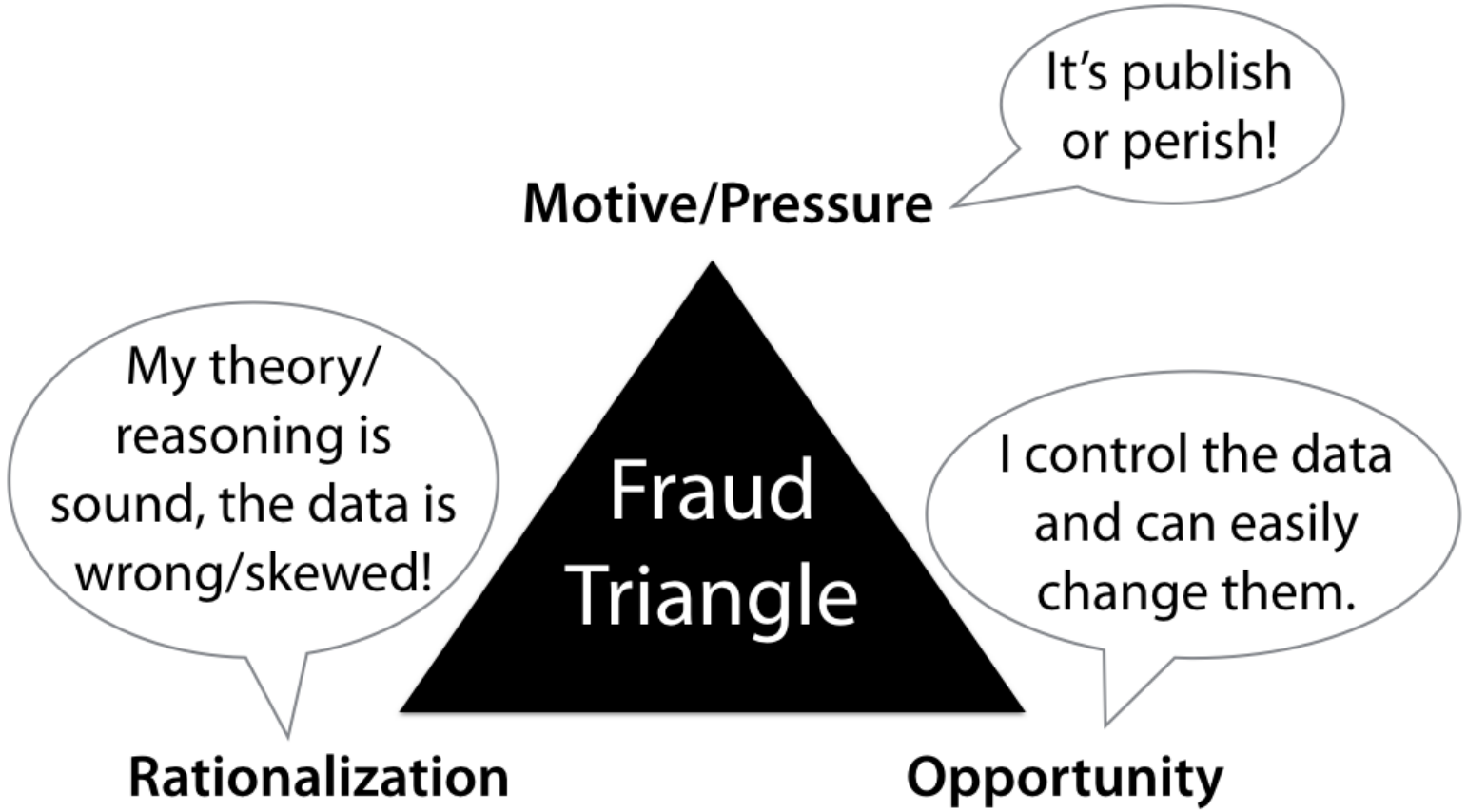
More of discouraging examples can be found on-line with key words:

culture of positive results in science

https://sciencenordic.com/basic-research-basic-research-crisis-denmark/scientists-there-is-too-much-focus-on-positive-results/1442690

https://elifesciences.org/articles/21451

# The mechanism of fraud



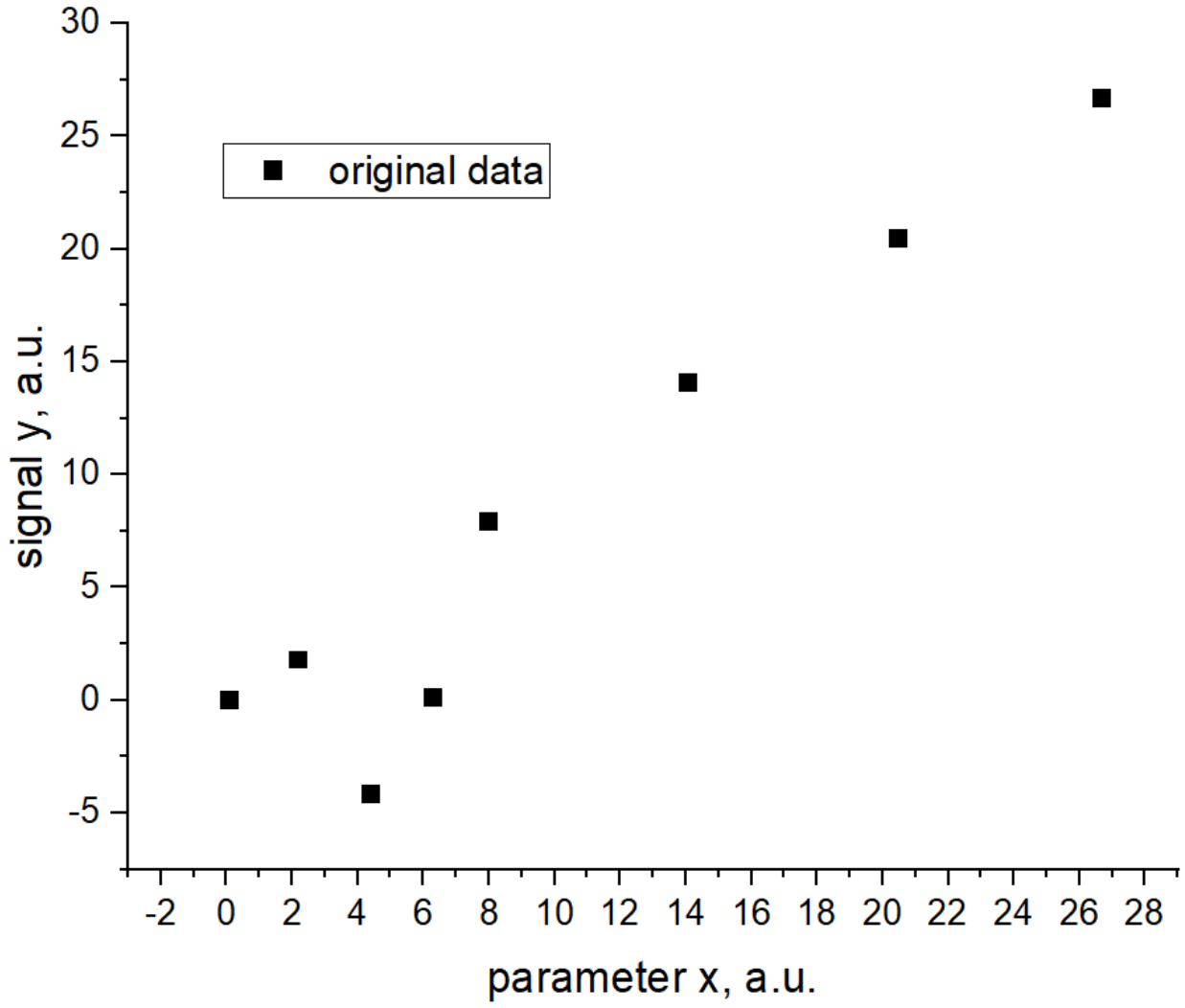

Fraud Triangle (by Donald R. Cressey) adapted to Scientific Misconduct

www.organizingcreativity.com/2014/08/using-the-fraud-triangle-to-explain-scientific-misconduct/

# Data abuse
# or the wrong take on “fake it till you make it”

*Statement: No real data sets were harmed for the presentation purpose. Similarity to any other data published or measured otherwise is accidental. Data presented here are creation of the author and were manufactured solely as an example.*

# Original data




*"A scientist measured those data. The hypothesis predicted a monotonic/linear dependence. This scientist is happy because the data is what he expected.*

*Scientist says: "I have good data" and he deletes the two points. "*

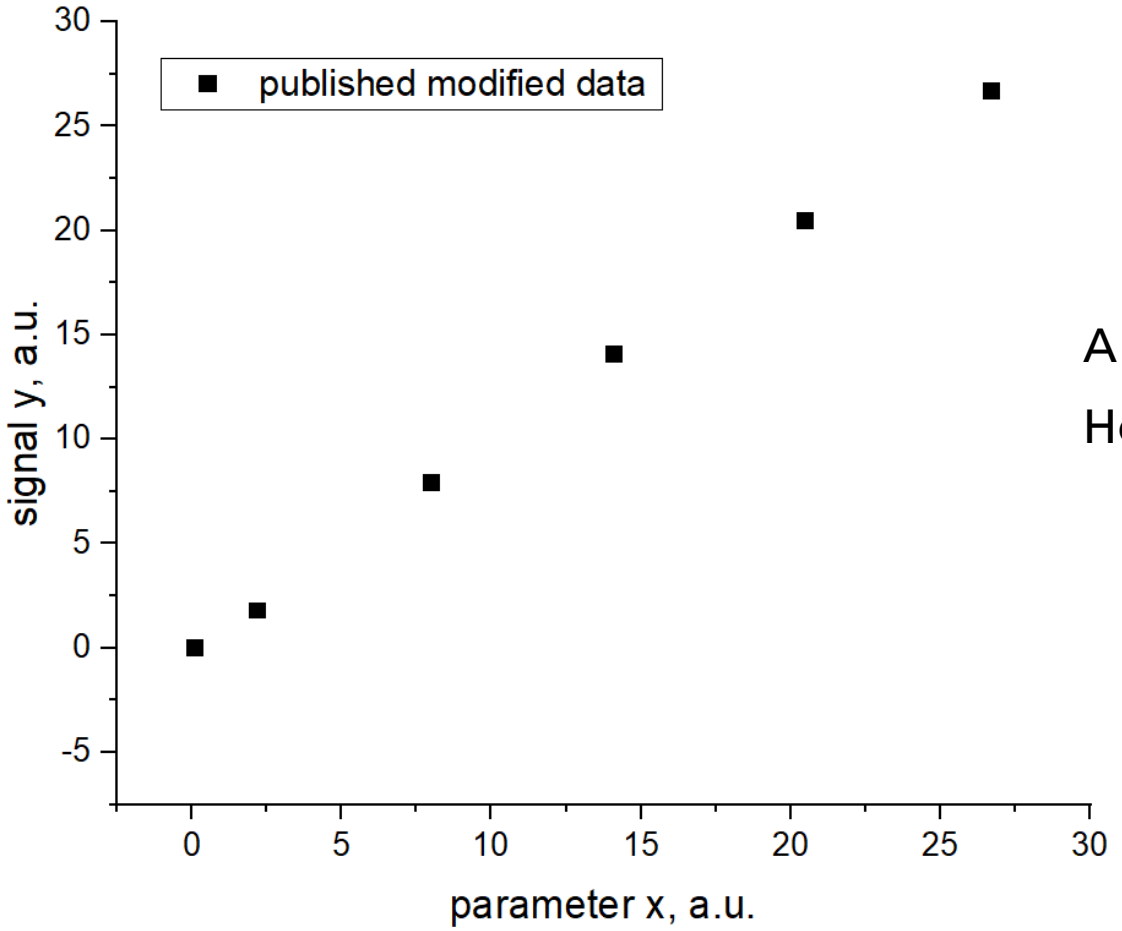
Q: Can he say that?

A: No, the scientist cannot make this statement.

Q: Why?

A: For the data to speak, there has to be statistics

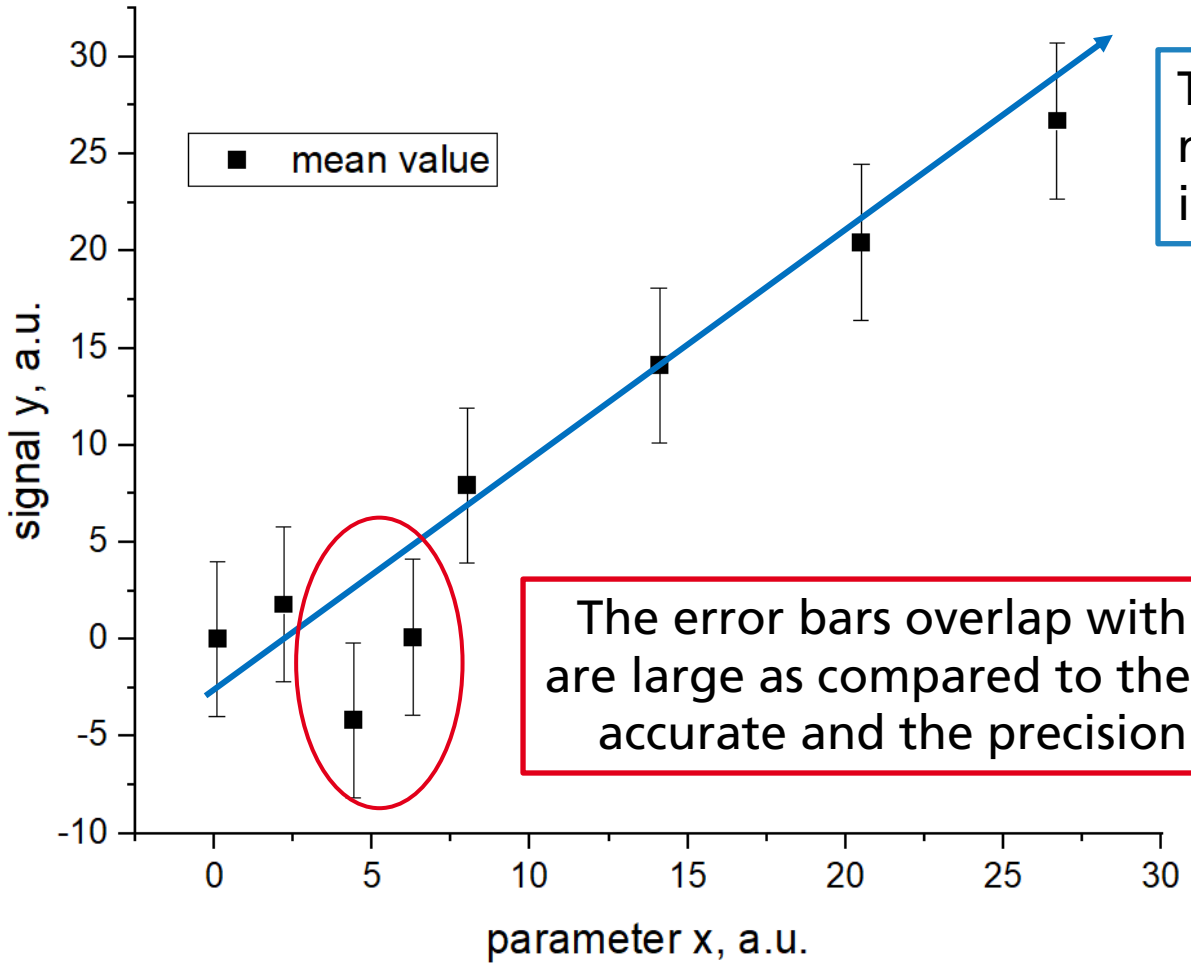
# Data were published like this




A theory was formulated, paper was published

However, the results were difficult to reproduce

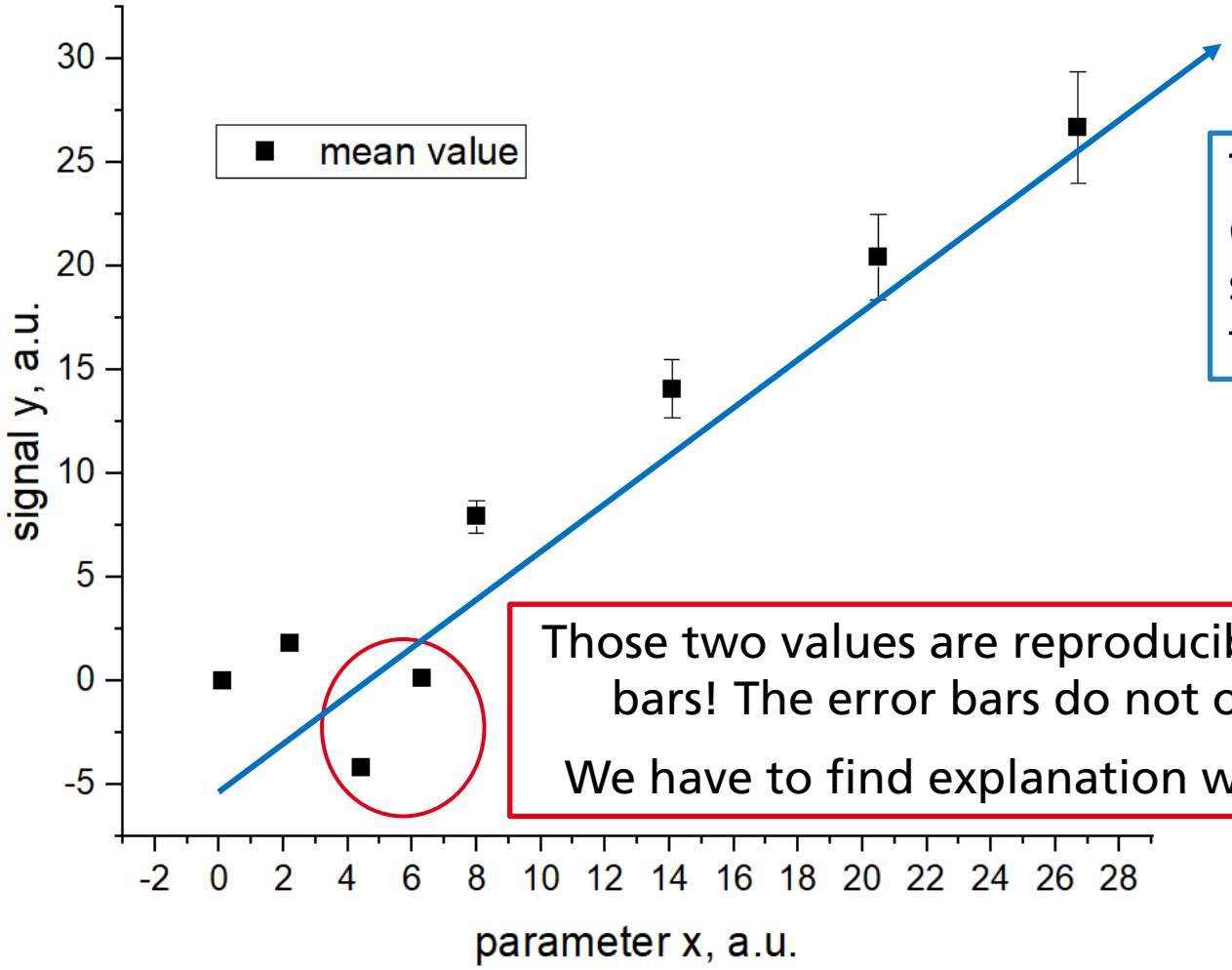
# 1st attempt to reproduce the data




The error bars overlap for the direct neighbors but the trend is monotonic, y is increasing with x.

The error bars overlap with the direct numbers. The error bars are large as compared to the mean values. Our system is not very accurate and the precision is also questionable in this range.

# 2nd attempt to reproduce the data



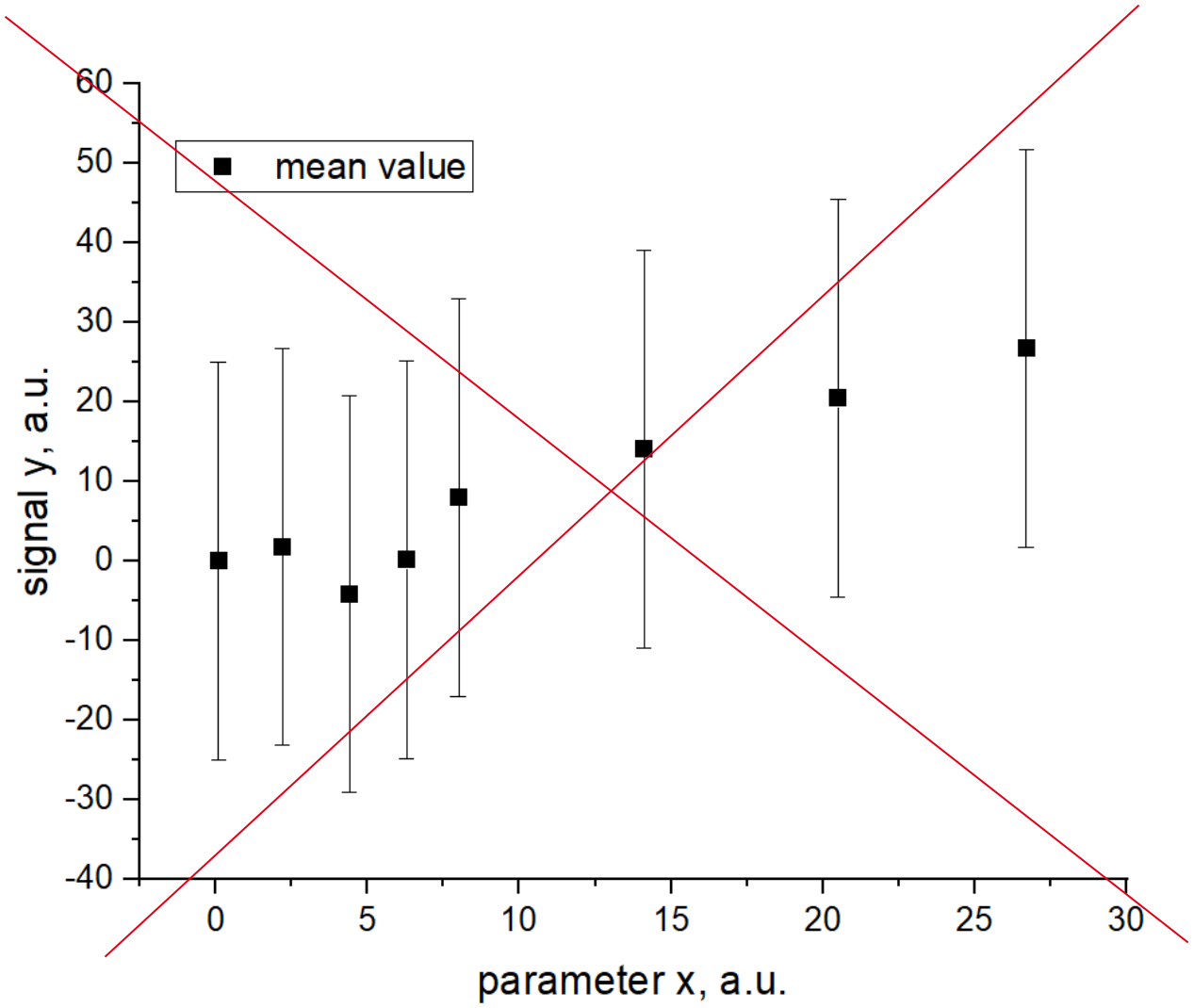

The data tells you:

The error bars overlap for the direct neighbors. Most of the signal values increases with the parameter x.

Those two values are reproducible, as they have very small error bars! The error bars do not overlap with the other points.

We have to find explanation why they don't follow the trend.

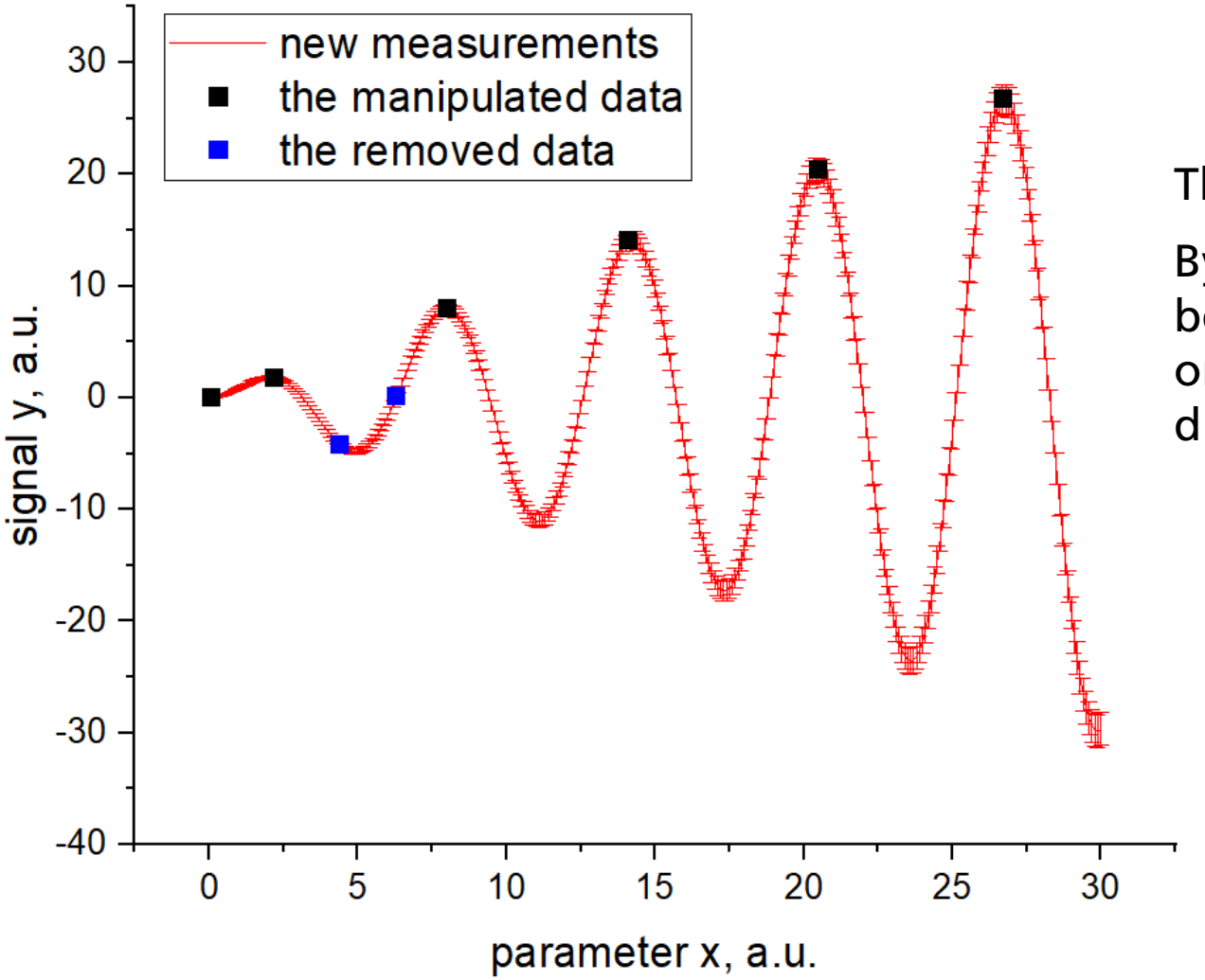
# Let’s not talk about it




The data tell you:

- Measurements setup is broken
- The measurement settings are wrong
- You don’t know what you are doing….

# The important attempt to explain the data




The conclusion of the first paper was wrong.

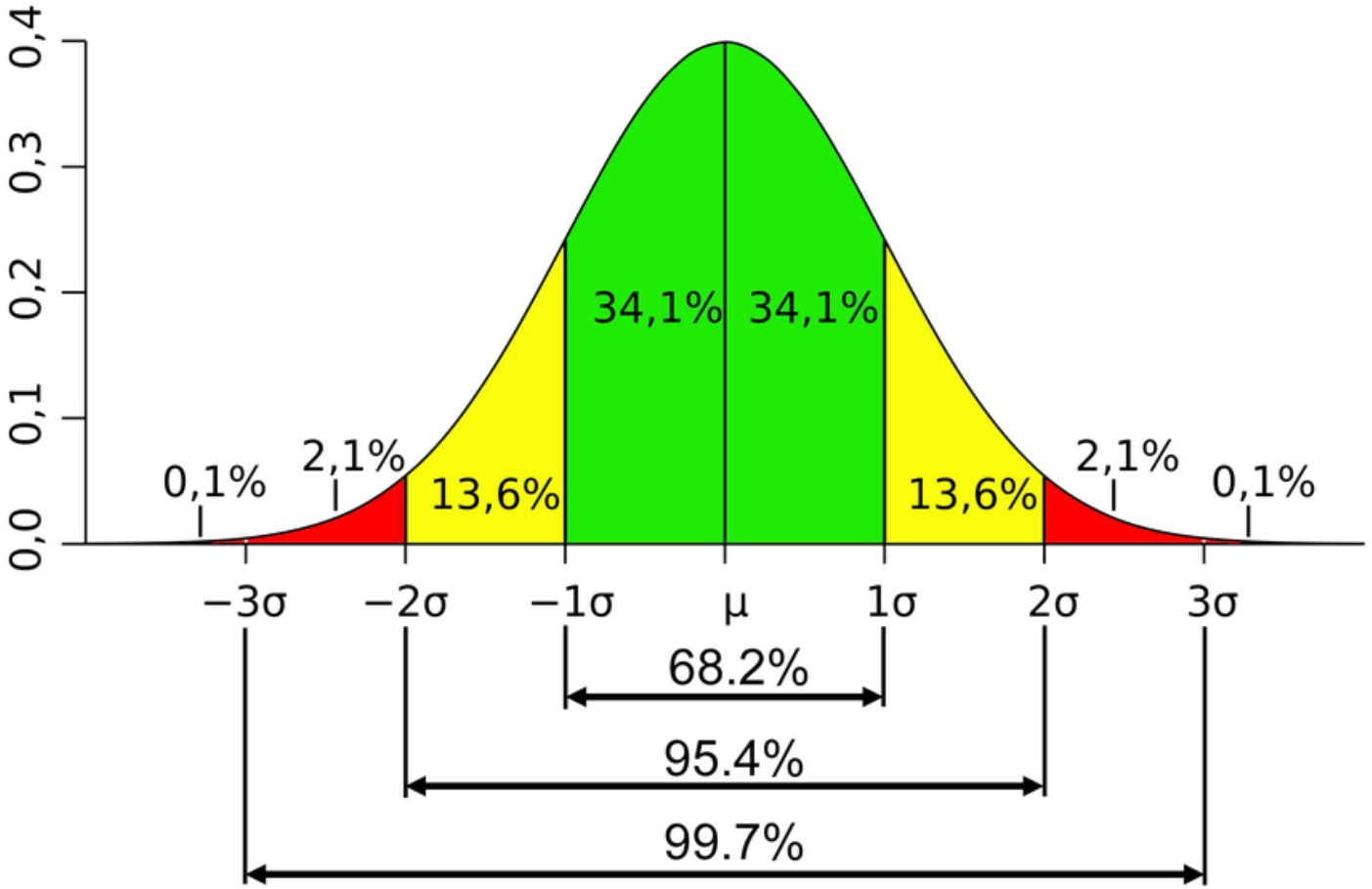
By not following and explaining the strange behavior of the two points, the author of the original publications lost an interesting discovery….

# Measurement protocol has to be based on some fundamental rules:

Our measured quantity Q is a continuous random variable

- The values measured will have normal distribution
- Each normal distribution has its own mean and its own standard deviation
- The shape is symmetric
- The mean and the median are the same
- The standard deviation measures the distance on the distribution from mean to the inflection point
- About 68% of data lie within one standard deviation from the mean
- About 95 % of the data lie within two standard deviation distance from the mean

# Summary on normal distribution (in this case Z distribution)




Normal distribution looks like Gaussian

Mean value and median are the same

μ and σ are the mean values and the standard deviation values

1 σ means difference equal 1 standard deviation

By analyzing the data with help of statistical distribution and standard deviation, we can decide which data are relevant, and which are “outsiders”

*kanbanize.com*

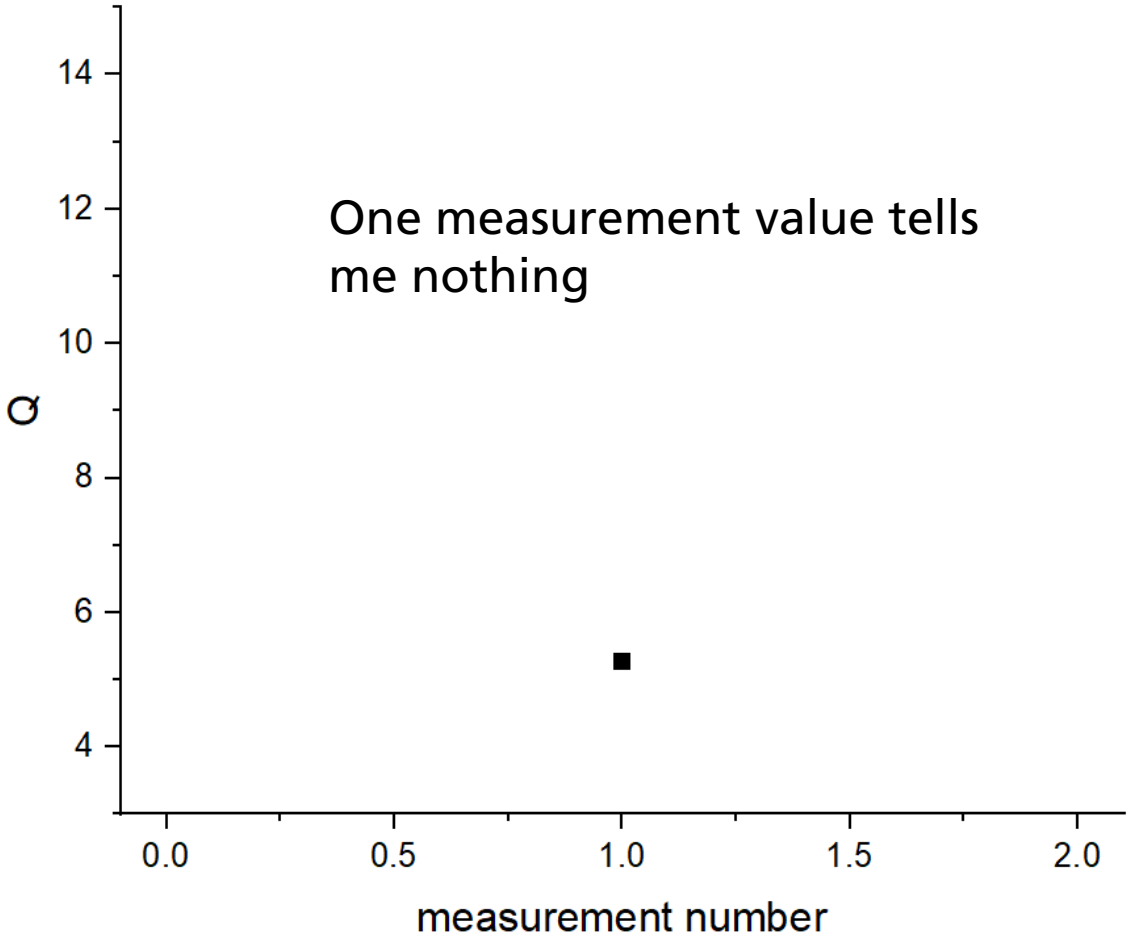
# Measurement protocol has to be based on some fundamental rules:

Formulate some important questions?

1. At which scale will I perform the measurement?
2. Is my equipment suitable in terms of sensitivity, range, stability?
3. Do I have to build my own system?
4. What is my reference in terms of value?
5. Do I need calibration procedure?
6. Will the scale influence the result?
7. …..

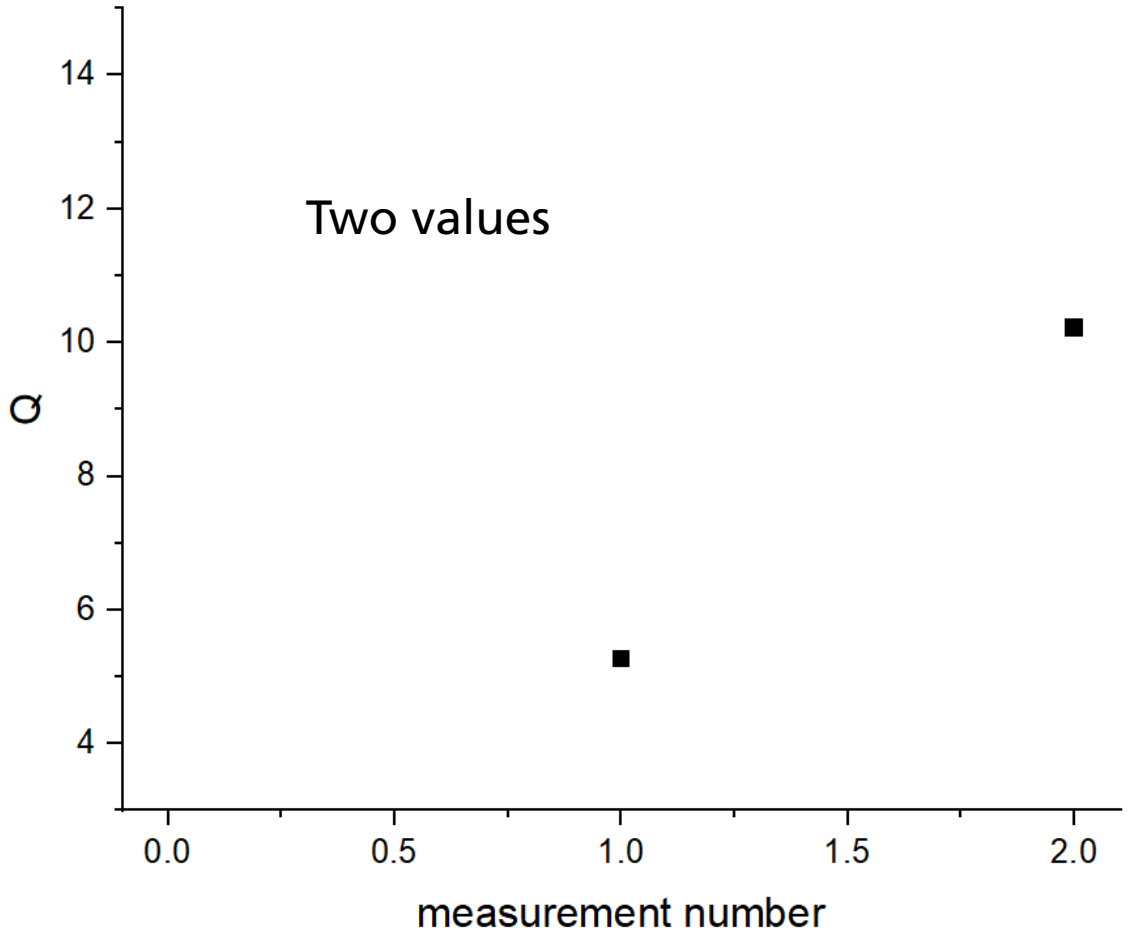
Make sure a similar or identical study has not been published already!

# I have to have enough data

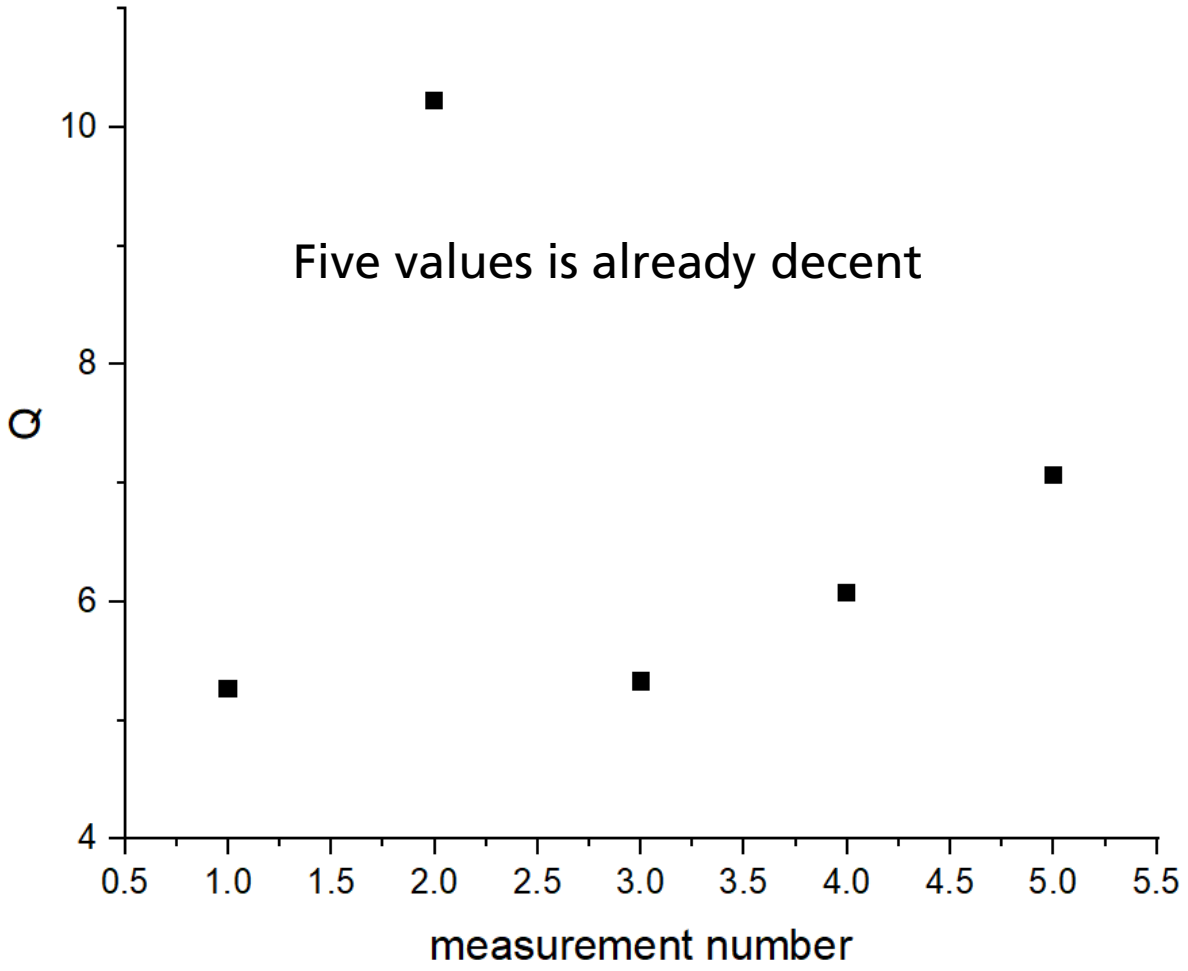



One measurement value tells me nothing

# I have to have enough data



# I have to have enough data



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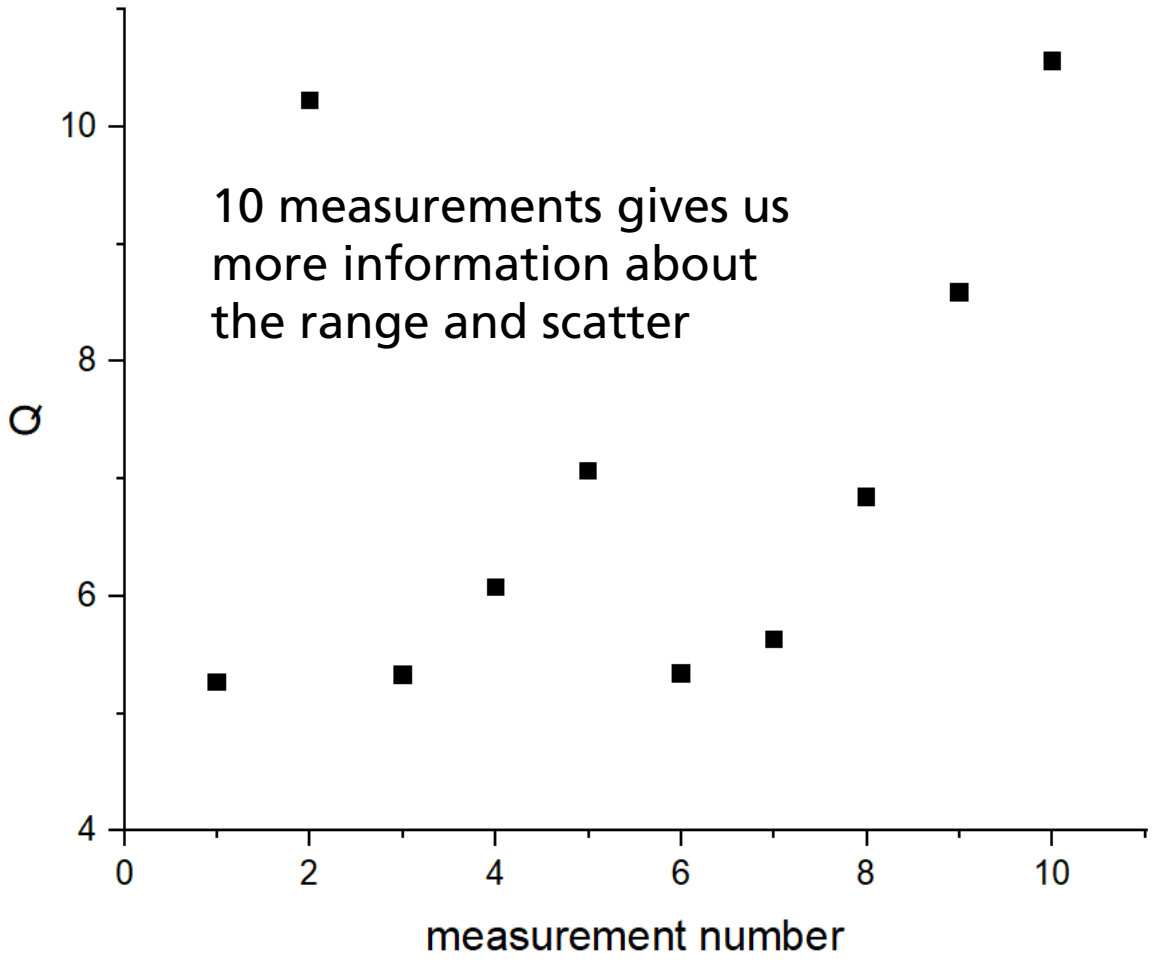
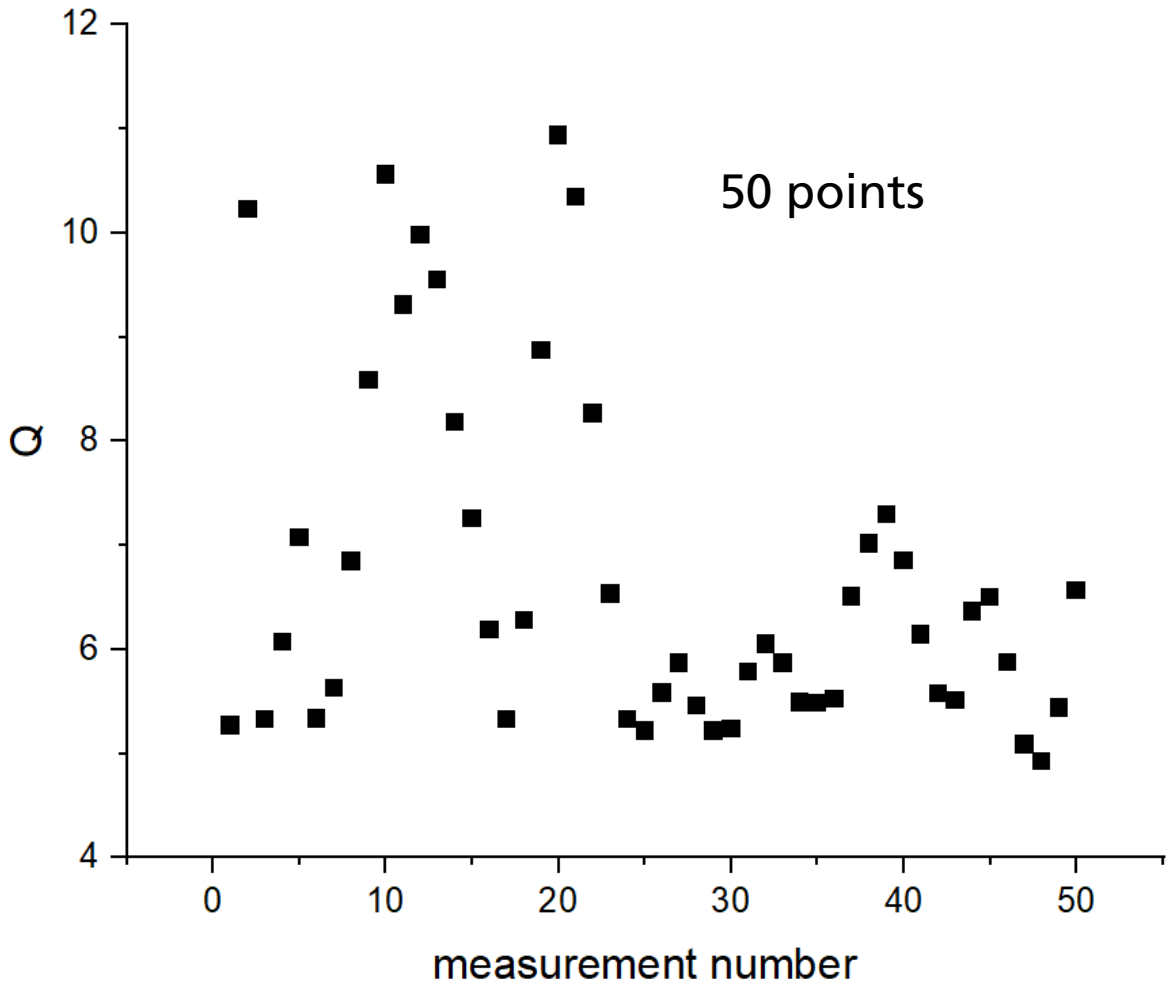


# I have to have enough data



# Does it make a difference?

| N | Mean | stdev |
|---|---|---|
| 1 | - | - |
| 2 | 7.7455 | 3.5023 |
| 5 | 6.7928 | 2.05055 |
| 10 | 7.0917 | 2.02224 |
| 50 | 6.7138 | 1.67237 |
| N>18000 | 5.72129 | 1.22305 |

The data analysis tells me that in this case, already two measurements give me “decent” result.
The error bars overlap with the more precise measurement series.

The point is, I know it after performing more measurements!!!

# There are papers published with faked or manipulated data

How to spot data manipulation?

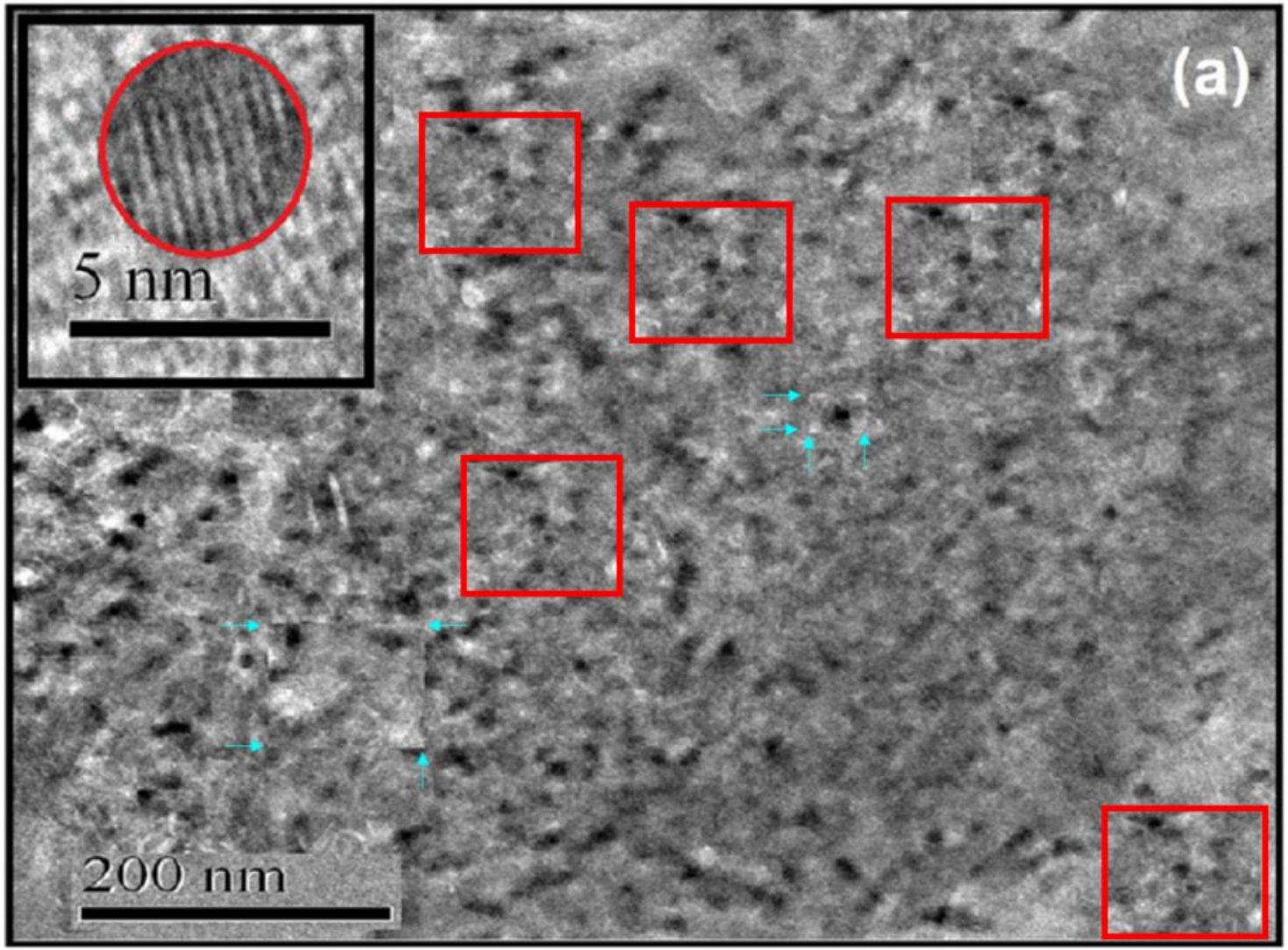
Look at the data

Ask questions

Compare the data with previously published results

Check, how fast the papers are published

# Real life examples (Forbetterscience.com)



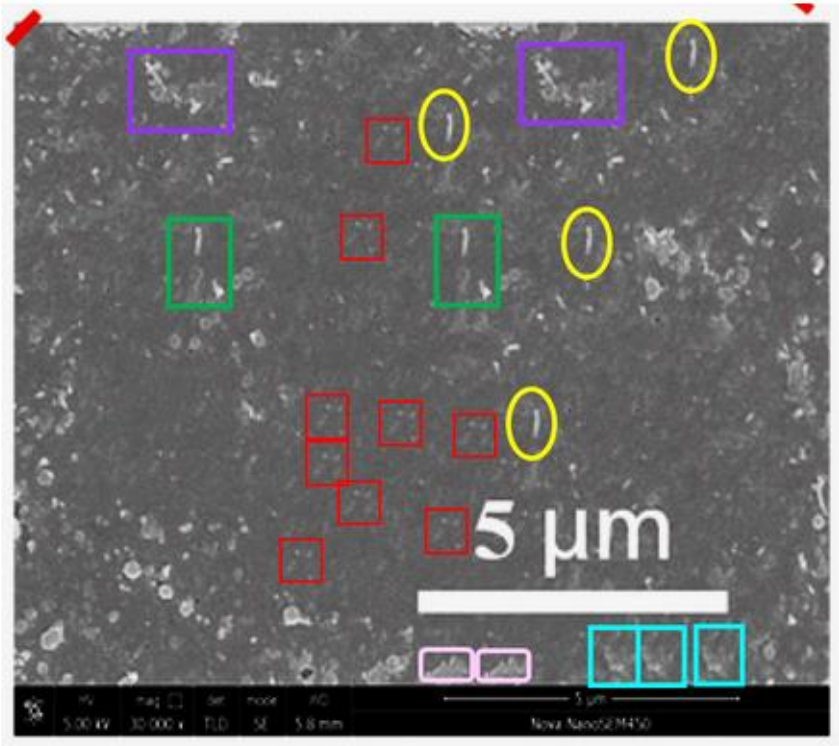

https://forbetterscience.com/2021/10/11/bad-choices-in-dresden/

Source of the figure:

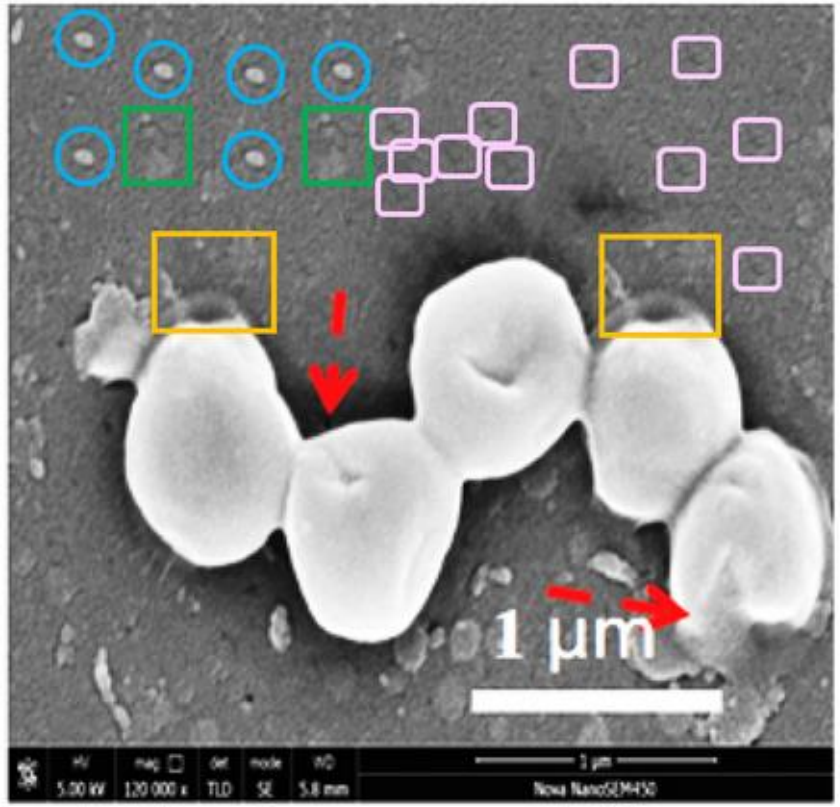
Bibekananda De , Brigitte Voit , Niranjan Karak Transparent luminescent hyperbranched epoxy/carbon oxide dot nanocomposites with outstanding toughness and ductility *ACS Applied Materials & Interfaces* (2013) doi: 10.1021/am402415g

- Identical (!) structures,
- image manipulation,
- copy/paste scale bar

# Real life examples (Forbetterscience.com)




From Figure 2B
Journal of Materials Chemistry B (2019) - 0 Comments
doi: 10.1039/c9tb01199d issn: 2050-750x

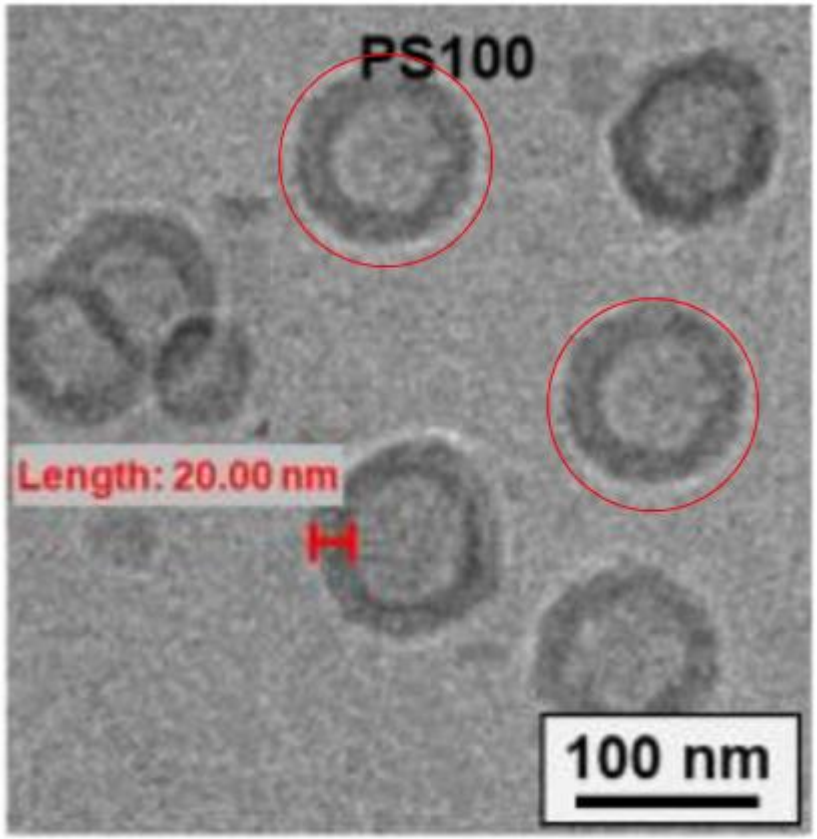



From Figure 7C
Journal of Materials Chemistry B (2019)
doi: 10.1039/c9tb01199d issn: 2050-750x

Identical features within the corresponding geometrical shapes

https://forbetterscience.com/2021/10/11/bad-choices-in-dresden/

# Real life examples (Forbetterscience.com)




**Withdrawal: Quantitative Synthesis of Temperature-responsive Polymersomes by Multiblock Polymerization**

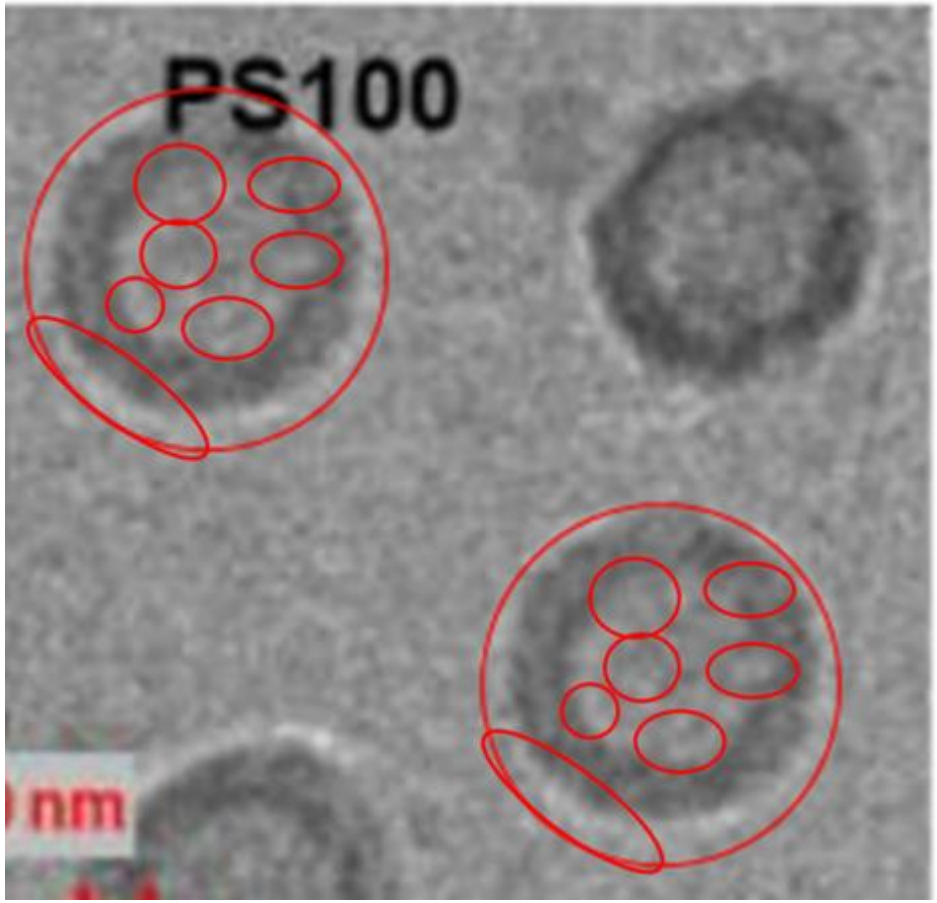
Angewandte Chemie International Edition (2021) - 9 Comments

doi: 10.1002/anie.201910138 issn: 1433-7851 pubmed: 31411370 issn: 1521-3773

Xiaoling Liu, Dongxu Zhou, Yunbo Feng, Jing Gou, Chenxi Li, Chao He, Weifeng Zhao, Shudong Sun, Changsheng Zhao, Dietmar Appelhans, Brigitte Voit

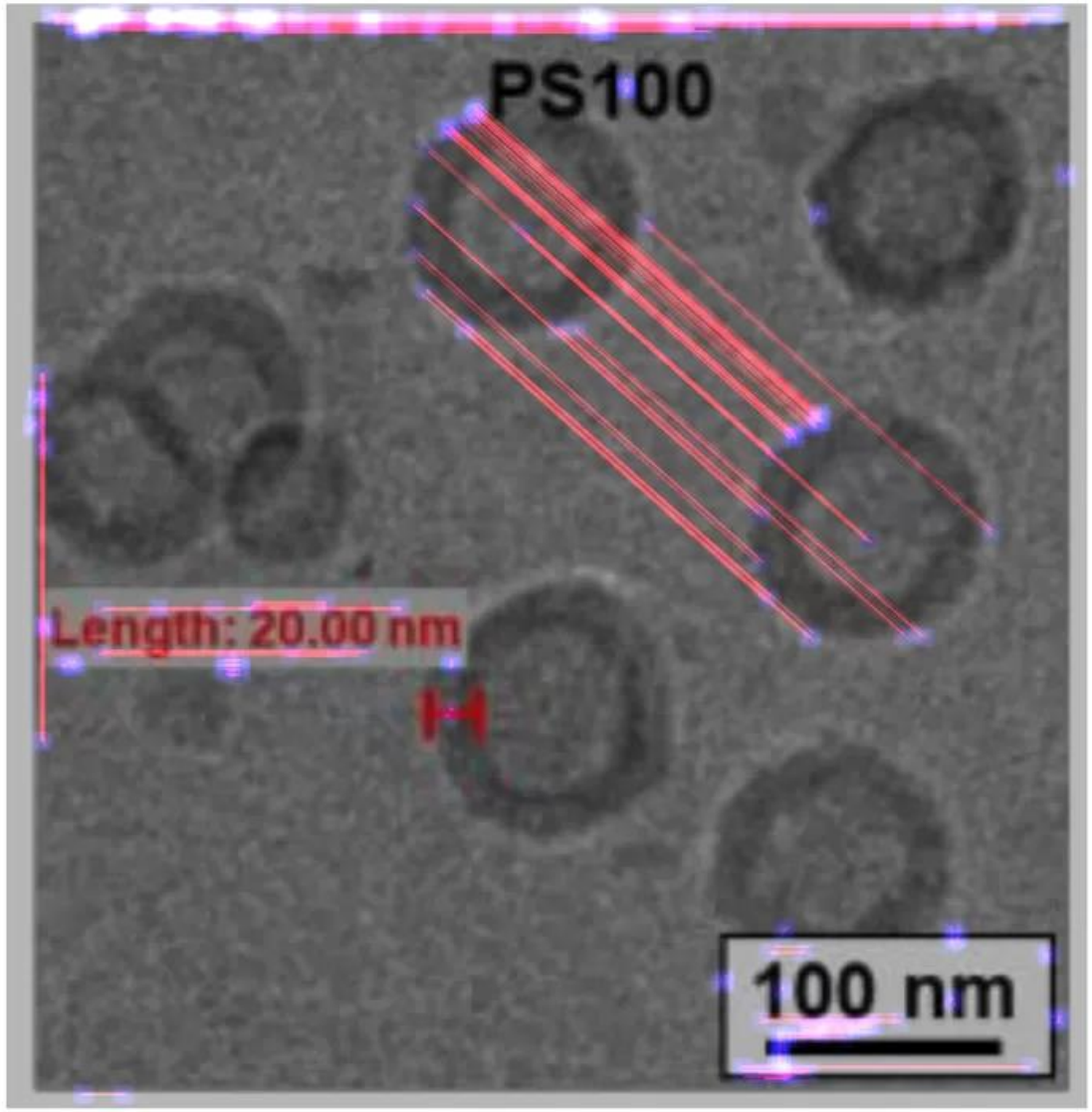
*"On Fig 4 two polymersomes look exactly the same pixel-wise"* by ***Chilocorus politus***

https://pubpeer.com/publications/081CB94A0F970314B7DC59D3188E6F



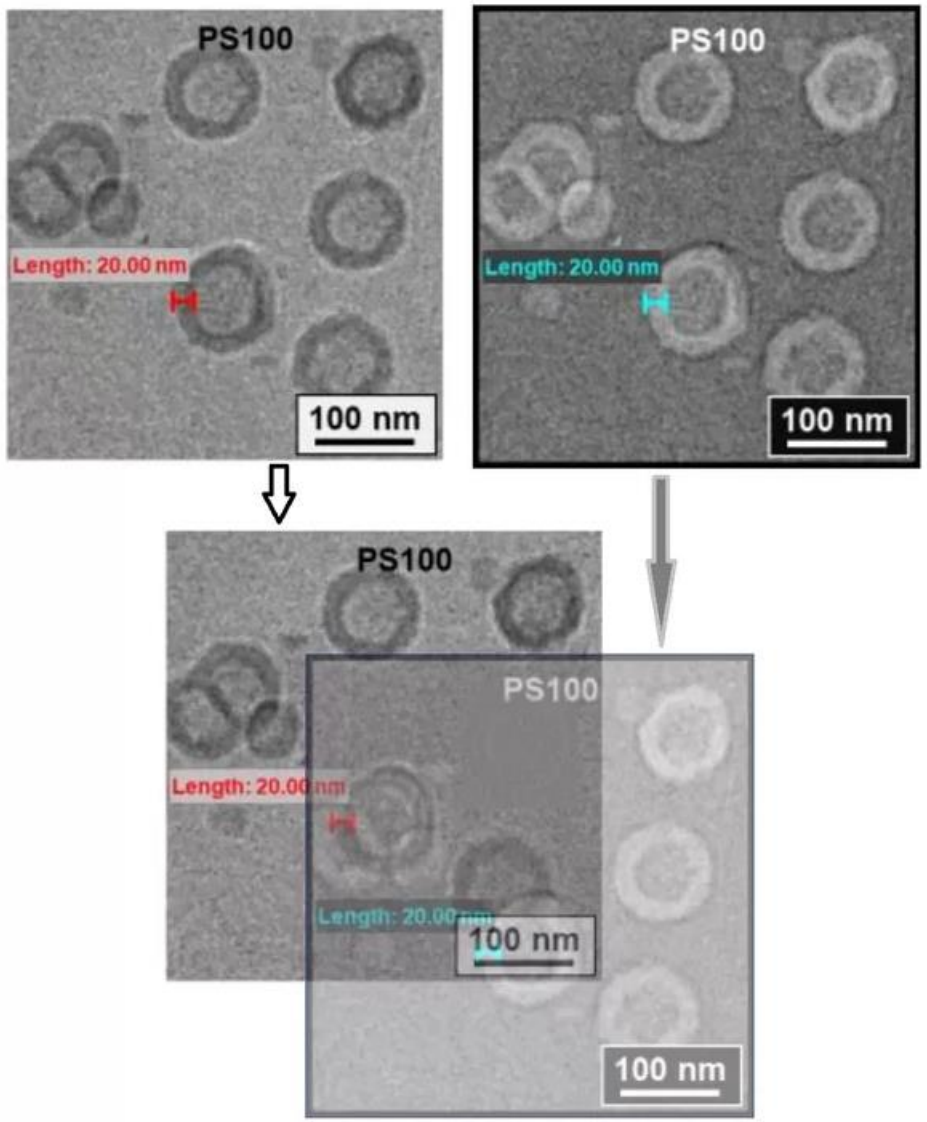

**The author**: *"Many thanks for your comments. First, It is possible to obtain the same shape of polymersomes for the cryo-TEM image, which is caused by the shape of the polymersome itself, the water environment inside and outside the capsule and the preparation process of sample. In addition, when we zoom in on these two polymersomes (as shown below), there are still many differences, such as color depth."*

https://pubpeer.com/publications/081CB94A0F970314B7DC59D3188E6F

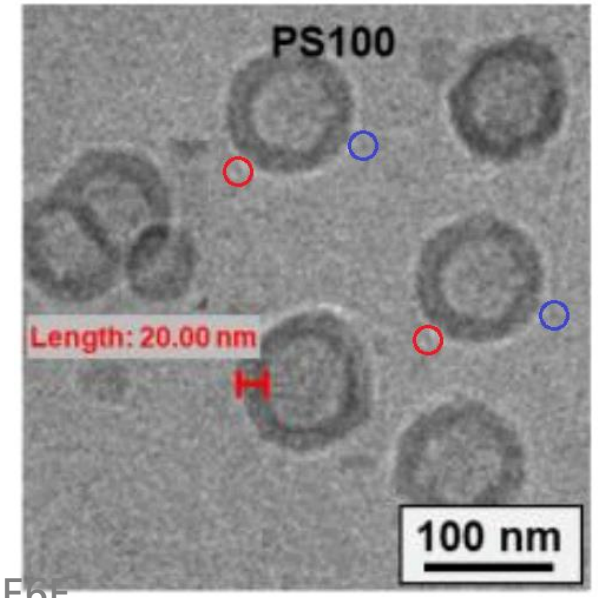



**Elisabeth M Bik**: „*I agree with Chilocorus Politus. These two particles look exactly the same to me. In fact, the areas circled in #2 only highlight the similarities…. Forensically also agrees with our OP. From https://29a.ch/photo-forensics/#clone-detection, with Minimal Cluster Size = 7. “*

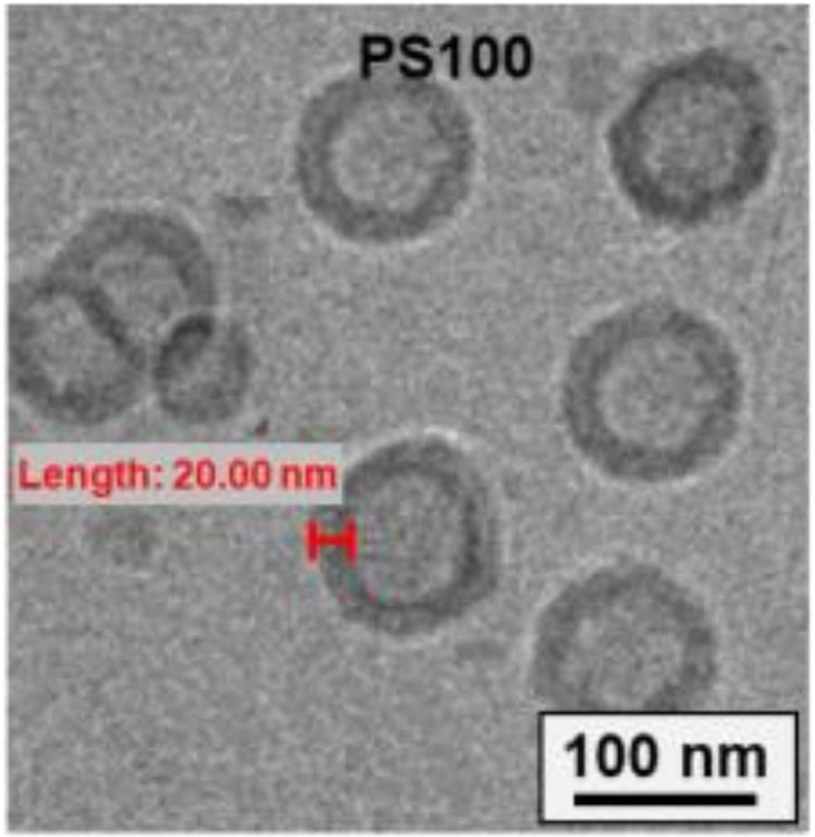
https://pubpeer.com/publications/081CB94A0F970314B7DC59D3188E6F

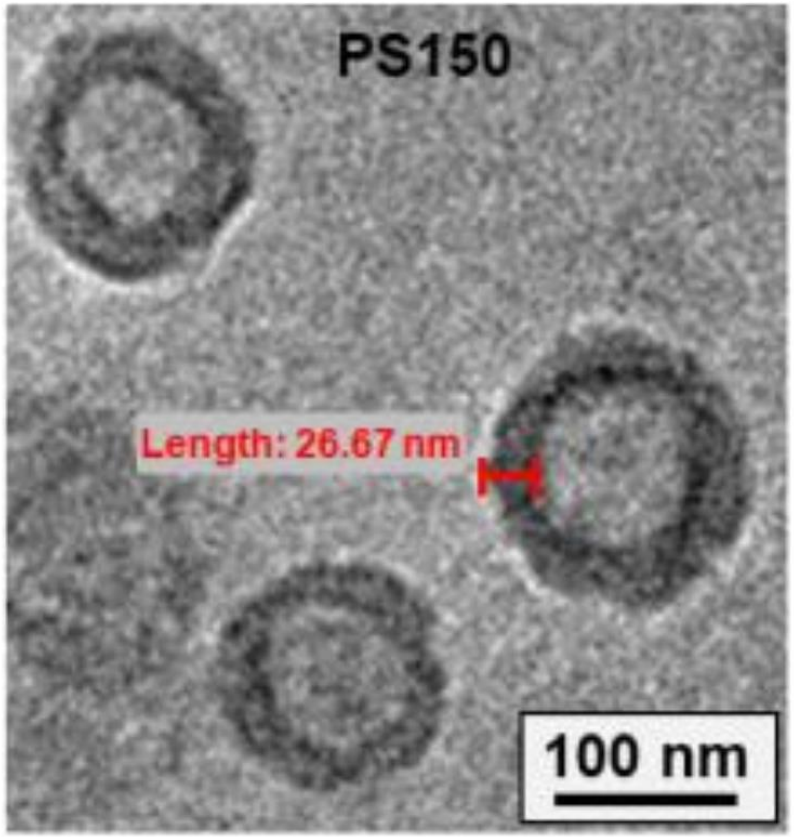



***Hoya camphorifolia**: Note that the two particles have not only identical internal structure, but identical alignment as well. That is, the physical processes of "the shape of the polymersome itself, the water environment inside and outside the capsule and the preparation process of sample" result in rotating the particles in precisely the same way… It is also of note that the physical processes have caused the support membrane of the TEM to display identical texture in the immediate neighbourhoods of the two particles."*




https://pubpeer.com/publications/081CB94A0F970314B7DC59D3188E6F




*Salsola zygophylla: „Also of interest is the next panel in this figure, where P150's imaged at the same magnification (re scale bar) show much coarser graining consistent with digital enlargement"*

https://pubpeer.com/publications/081CB94A0F970314B7DC59D3188E6F

***Acanthobothrium oceanharvestae**: „Actually, the TEM figure of PS150 is from the figure S6 of her previous paper (DOI: 10.1002/anie.201708826)"*

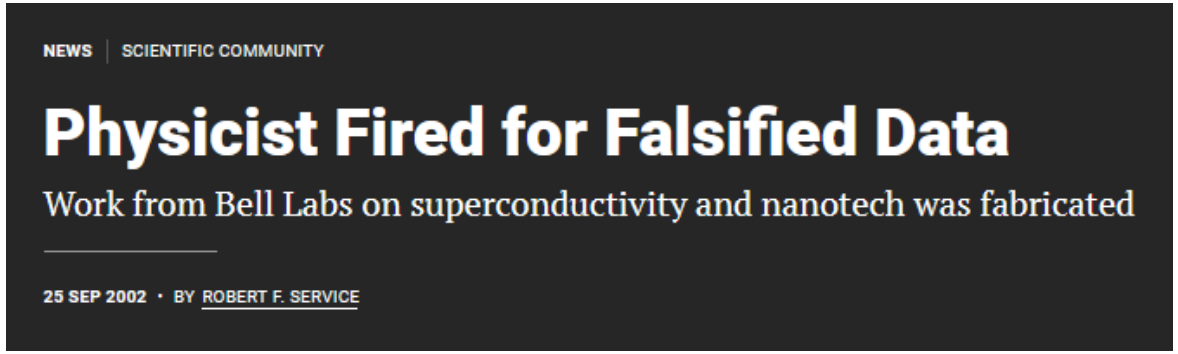
***Hoya camphorifolia**: "This Communication, published online on 14 August 2019 in Wiley Online Library (wileyonlinelibrary.com), has been withdrawn by agreement between the corresponding authors, the journal's Executive Committee, and Wiley-VCH GmbH, Weinheim. The withdrawal has been agreed upon following the explanation by the authors that problems with a microscopy image presented in Figure 4 of the article cannot be fully clarified."*

***Orchestes quercus**: „The retraction notice is a bit modest here. As #7 noted, the PS150 microscopy image is presented in 'Functional Cellular Mimics for the Spatiotemporal Control of Multiple Enzymatic Cascade Reactions' / https://doi.org/10.1002/anie.201708826 as something else: ' Cryo-TEM images of Ada-Psome photo-crosslinked for 20 min at pH 8'. See collage below (#1, #5, #7). „*

Process of retraction took 2 years

https://pubpeer.com/publications/081CB94A0F970314B7DC59D3188E6F

# Schön scandal



NEWS | SCIENTIFIC COMMUNITY

**Physicist Fired for Falsified Data**

Work from Bell Labs on superconductivity and nanotech was fabricated

25 SEP 2002 • BY ROBERT F. SERVICE

Summary: J. H. Schön worked for Bell Labs from 1998 till 2002. He falsified data in 16 out of 24 papers published in high rank journals. Schön either fabricated or falsified his data. As the original data was deleted, all his statements could not be verified. Non of his co-authors noticed that there may be something wrong even if scientific reports were produced at rates of about 1/week. The forgery was noticed by groups trying to reproduce his data. It was noticed that too many results were similar and /or identical where they should be governed by stochastic processes.

In numbers:

9 papers were retracted from **Science**

6 papers were retracted from **Physical Review**

4 papers from **Applied Physics Letters**

7 papers retracted from **Nature**

2 papers from **Advanced Materials**

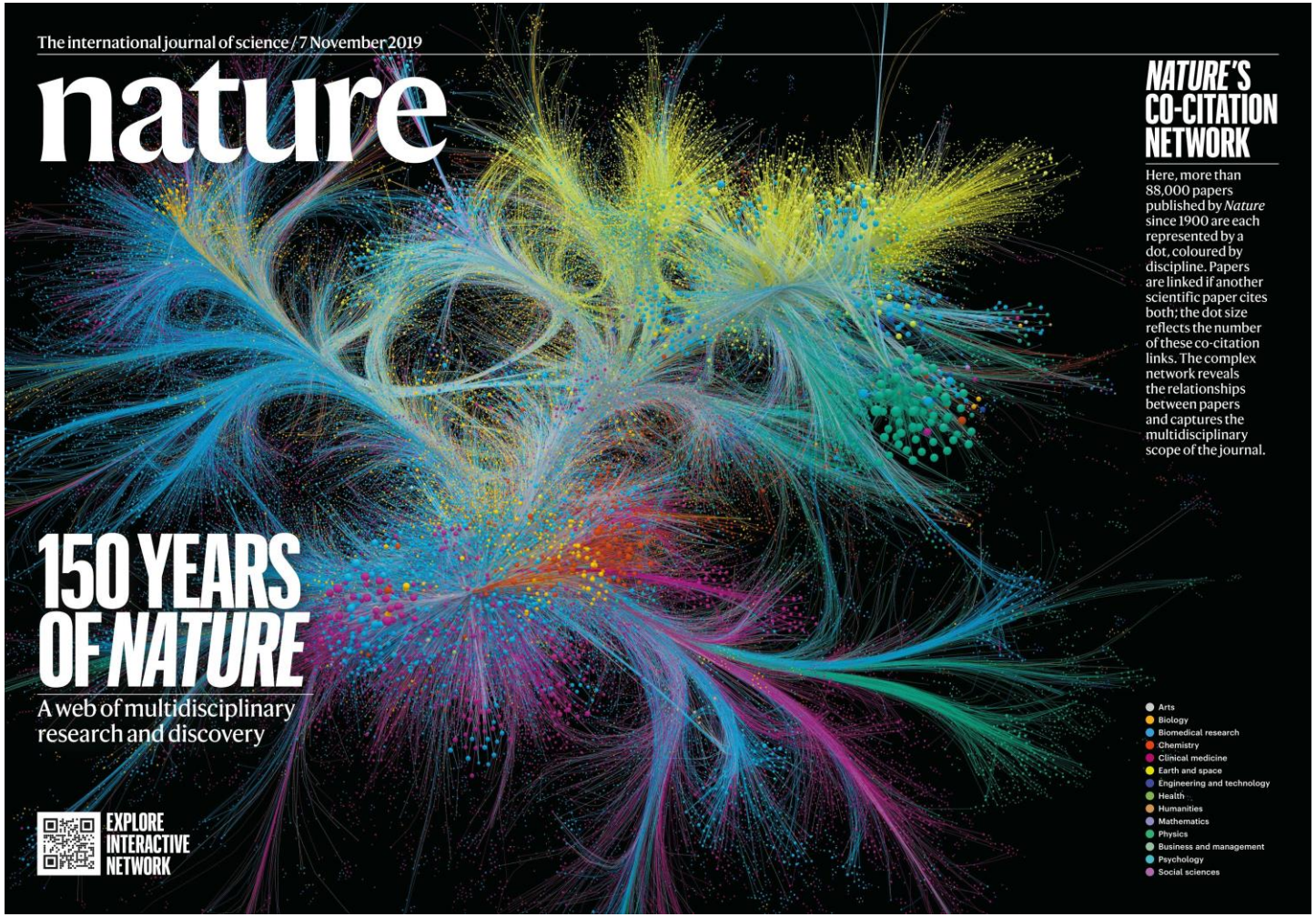
27 of those papers were published within two years!

**1 "hard core" paper/four weeks**

# Important and disturbing facts

1. About 20 people were named co-authors on a regular basis, including direct supervisor.
2. Papers were published in Science and Nature, the highest IF papers. The review process is there to ensure the high quality of the journals.
3. Papers were published at incredibly high rate. The rate was way too high for an experimental physics.
4. It took the effort of several groups and their inability to reproduce the data to blow the whistle.

# The impact of fraud




Graphic by Albert-Laszlo Barabasi presenting the complex interconnections of the papers published in Nature. Each spot is a paper, each thread a citation.

"Fake" science is like a parasite

# Fake research is an obstacle

| | | |
|---|---|---|
| “fake research” | ⇒ | Waste of research money |
| “fake research applied” | ⇒ | Negative consequences (even deadly if in medical or pharma related fields) |
| Validation of “fake research” | ⇒ | Waste of time and money of other research groups, slows down other research |
| “fake research” gets more publicity | ⇒ | News on “fake” research are fast spreading and they undermine the status of science |

Worst example: Andrew Wakefiled – former physician and discredited academic who published a paper claiming a link between vaccination and autism. There were records of patents for new vaccination developed by Wakefiled (1997) (supposedly better and safer) prior to his infamous paper in Lancet (1998)

Wikipedia, briandeer.com/wakefield/vaccine-patent.htm

# Documentation as a tool for quality assurance

## documentation

/ˌdɒkjʊmɛnˈteɪʃ(ə)n/

*noun*

1. material that provides official information or evidence or that serves as a record.
   "you will have to complete the relevant documentation"
2. the process of classifying and annotating texts, photographs, etc.
   "she arranged the collection and documentation of photographs"

Definitions from Oxford Languages

https://www.pilz.com/en-INT/support/knowhow/law-standards-norms/manufacturer-machine-operators/technical-documentation

# Experiment

## Lab book

Old fashioned notebook for handwriting that contains:

1. Numerated pages
2. Owner's name
3. Date of the experiment
4. Parameters of the experiment
5. Sequency of the measurement
6. Note on the name of the files
7. Notes about possible disruptions
8. Observations

9….

Also helpful:

Vocal recordings describing the procedure logged and documented in the lab book

Digital notes that are referenced in the lab book

In case of standard measurements:

Saving the data in organized and dedicated structure with date and self-explaining name

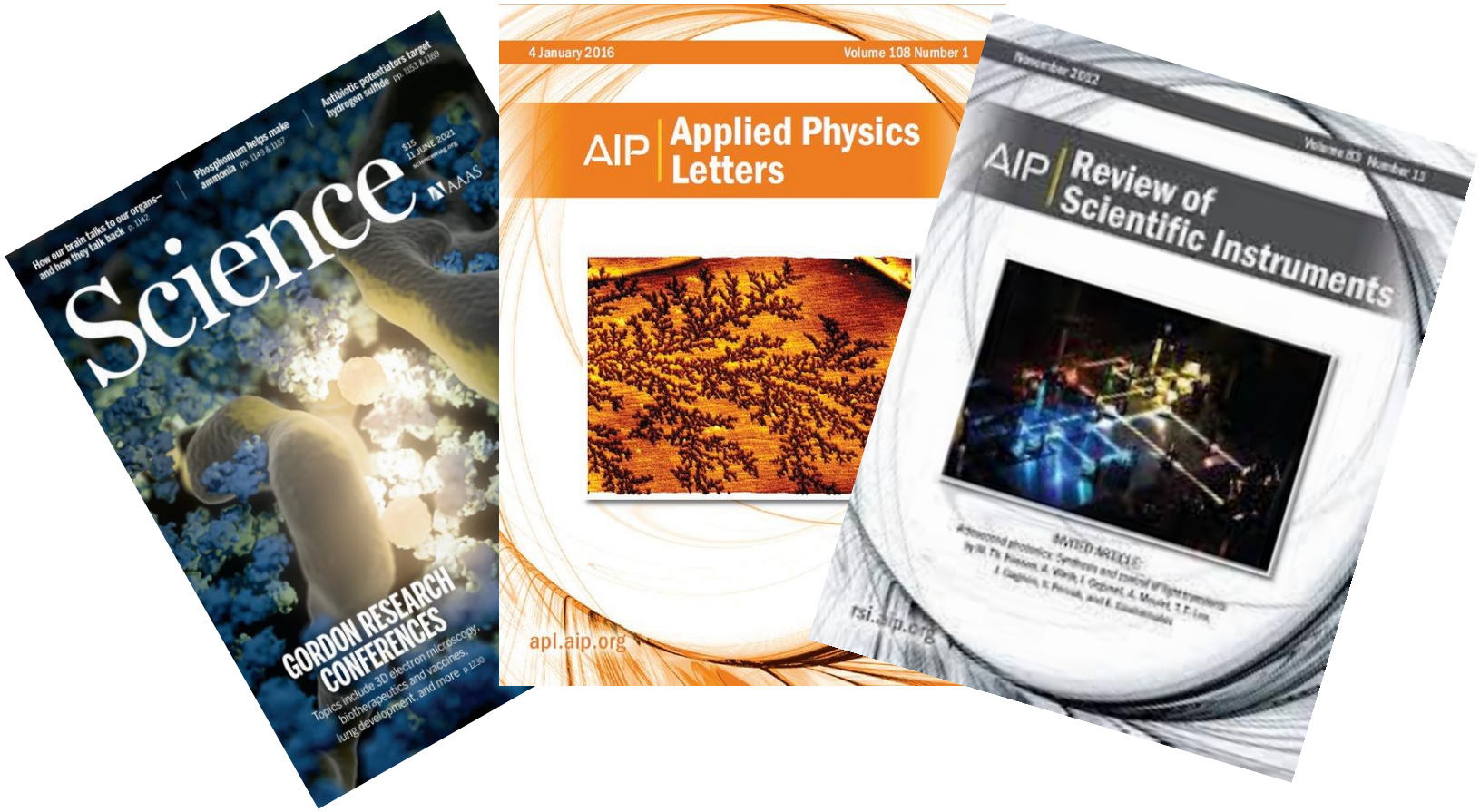
# Data analysis

Documentation of the data analysis steps:

- Hand written/digital notes with clear annotation
- Files with processed data saved with name informing about the processing
- Data processing done on a copy. Original files must be available
- Documentation on the data processing as well as the original data must be stored for at least ten years and available for review
- Data relevant for a given publication/report should be stored in one folder or referenced in a way enabling location.
- Relevant papers used to develop data analysis model should be stored in relevant folder
- Keep the copy of the subsequent paper drafts and the submission version

Different institutions have different rules for data handling. Follow the rules and make sure you can find your data and follow your thought process!

# Publishing your results




www.science.org, www.utwente.nl/en/news, www.attoworld.de

# Publishing

From an article

“ Authorship: why not just toss a coin?” by Kevin Strange, Am J Physiol Lell Physiol. 295, 2008, C567

The first guidelines regulating authorship were defined in 1978 by International Committee of Medical Journal Editors. Current version states that:

Authorship credit should be based on:

1. Substantial contribution to conception and design, or acquisition of data, or analysis and interpretation of data;
2. Drafting the article or revising it critically for important intellectual content
3. Final approval of the version to be published

In other words you can and should be author/co-author if you measured the data beyond the standard task, performed analysis, provided critical information to the data analysis, wrote parts of the paper, revised and discussed all of it with other co-authors

# It is all about intellectual contribution

*"Acquisition of funding, collection of data, or general supervision of the research group, alone, does not justify authorship"*

Acquisition of funding deserves acknowledgement!

# Authorship order and the meaning

In most of the cases:

1st author – did the largest portion of the experimental work, data analysis, writing contribution. Often he is also the corresponding author

Last author – aka "senior" author has to direct, oversee, and guarantee of the work reported. Very often senior author is also the corresponding author

Middle or contributing authors – they are listed between the first and the last author in order related to their contribution

Many journal require statements with description of the contribution. The corresponding author is obliged to provide this kind of information

# Authorship abuse

Coercive authorship (White Bull effect) – senior individuals (boss, head of the department) demanding authorship without  his/her intelectual contribution (abuse of senior position)

Ghost authorship – a writer is paid for writing a scientific study without contributing his name (usually abuse done by pharma industry)

Guest authorship – when a renewed scientist is paid to guarantee the credibility to a study without providing intellectual input (often pharma industry) or to gain a favor with the said scientist

Not recognized contribution: when intellectual contribution of a third party is used without permission and recognition in form of authorship

# Case of Rosalind Franklin

*"Meanwhile, at the Cavendish Laboratory at Cambridge, Francis Crick and James Watson were working on a theoretical model of DNA. Though not in close communication with Franklin, in January 1953 they gleaned crucial insights about DNA's structure from one of her x-ray diffraction photos shown to them by Wilkins, and from a summary of her unpublished research submitted to the Medical Research Council. Watson and Crick never told Franklin that they had seen her materials, and they did not directly acknowledge their debt to her work when they published their classic announcement in Nature that April. Crick later admitted that Franklin was two steps away from realizing the correct structure in the spring of 1953."*


Rosalind Franklin in 1950. She, like Crick, had realised that DNA had a double helix structure. Photograph: Vittoria Luzzati/NPG

*Crick, Watson, and Wilkins shared the 1962 Nobel Prize for Physiology or Medicine for their work on the structure of DNA. None gave Franklin credit for her contributions at that time.*

*https://profiles.nlm.nih.gov/spotlight/kr/feature/biographical*

# Resolving authorship problems

The senior author has to know who provided intellectual contribution.

Inform the senior author and ask for an explanation

Document your communication

If not resolved, contact an OMBUDSMAN (OMBUDSPERSON) at your institution.

If your institution does not have one, there is usually one at government science funding institution (in Germany it is DFG)

ombudsman-fuer-die-wissenschaft.de

# Role of Ombudsman

**Advise** - The *Ombudsman* provides confidential advice on matters of research integrity and in specific cases of conflict (phone, e-mail, in person)

**Mediation** - Where conflicts related to good scientific practice occur, the *Ombudsman* assists by means of solution-orientated conflict mediation, following the rules of GSP.

**Propagation of GSP** – organizes seminars and talks with examples of GSP, builds network with other organizations to make sure that the rules for GSP are uniform

# It is also your job

## Transparency and communication

Document your ideas (!) and talk about them within your group including your supervisor.

- Different people have different ideas. Their insight may help you!
- You will have no problems with definition of authorship
- Errors and mistakes can be caught early on
- Success and responsibility are shared equally
- To learn constructive criticism you have to practice it
- Improvement in discussion culture
- Your ego will be in good shape ☺
- Discussing mistakes is maybe painful but incredibly valuable experience as it brings knowledge

***“Most people say that it is the intellect which makes a great scientist. They are wrong: It is character.”***

*Albert Einstein*