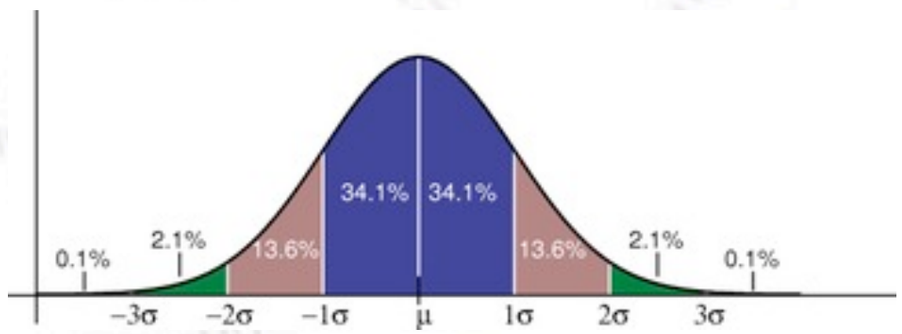
Applied Statistics

Troels C. Petersen (NBI)





"Statistics is merely a quantization of common sense"

Systematic Errors

Even with *infinite* statistics, the error on a result will never be zero!

Such errors are called "systematic uncertainties", and typical origins are:

- Imperfect modeling/simulation
- Lacking understanding of experiment
- Uncertainty in parameters involved
- Uncertainty associated with corrections
- Theoretical uncertainties/limitations

While the ***statistical uncertainty*** is Gaussian and scales like $1/\sqrt{N}$, the ***systematic uncertainties*** do not necessarily follow these rules.

When **statistical** uncertainty is largest, more **data** will improve precision.
When **systematic** uncertainty is largest, more **understanding** will improve precision.

The finding/calculation of systematic errors is hard work.

Everything is vague to a degree you do not realize till you have tried to make it precise. [Bertrand Russell]

Biased measurements

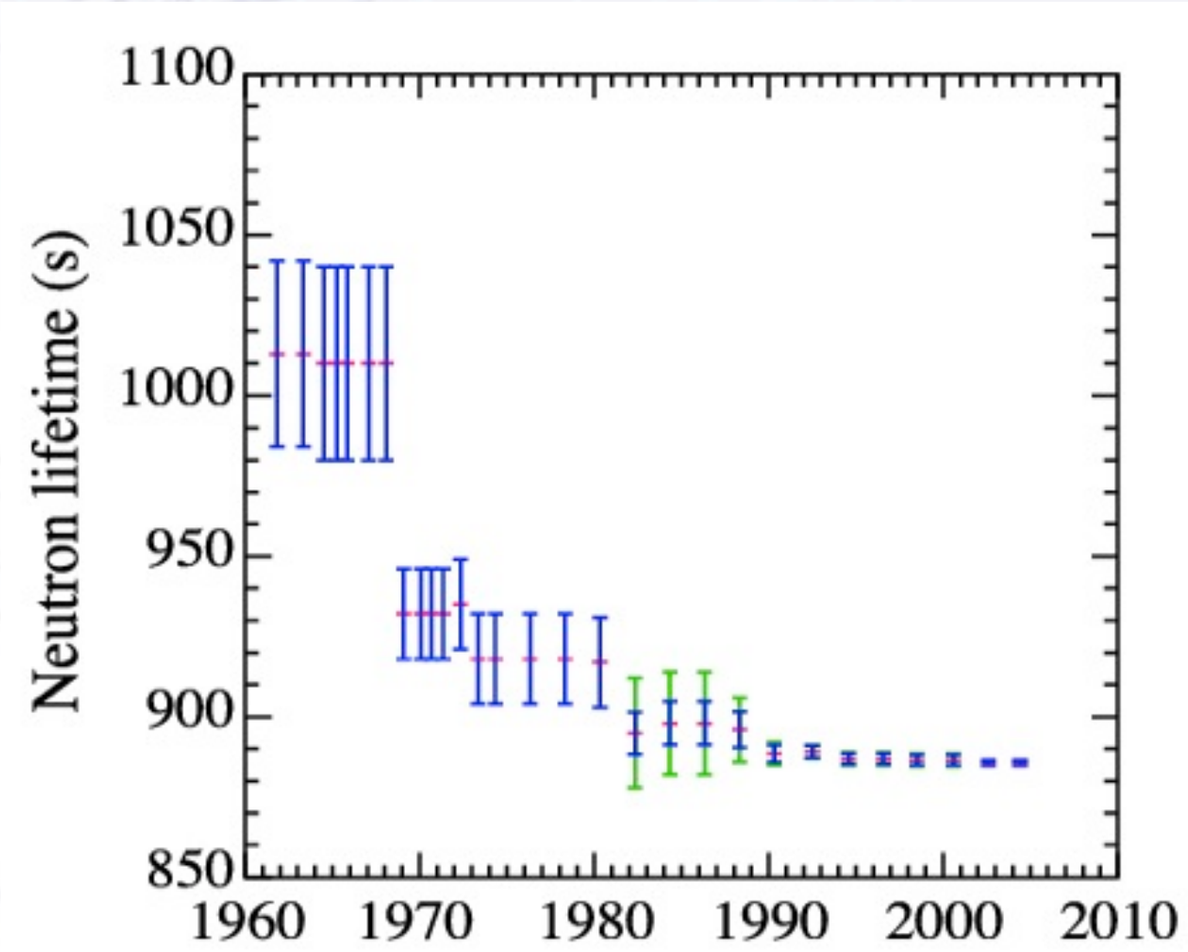
Why does my experiment find a lower value than others?

It is questions like these, that makes you start looking
for effects that could yield a higher value, leading to…

Biases!

When measuring a parameter for which there are already expectations/predictions, the result can be biased. Examples:

- Millikan's oil-drop experiment.
- Epsilon prime (CERN vs. FNAL).
- Any politically influenced decision.



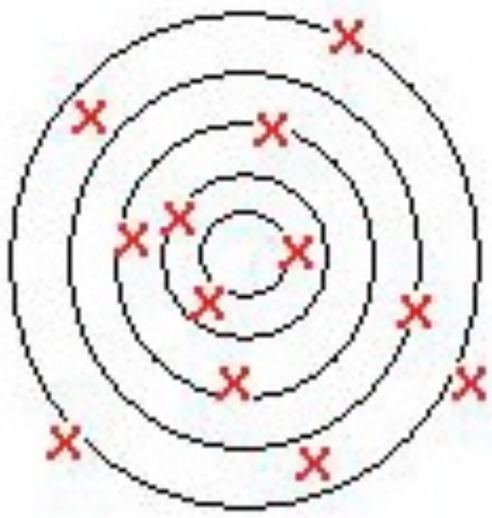
Those who forget good and evil and seek only the facts are more likely to achieve good, than those who view the world through the distorting medium of their own desires. [Bertrand Russell]

How to find systematic errors?

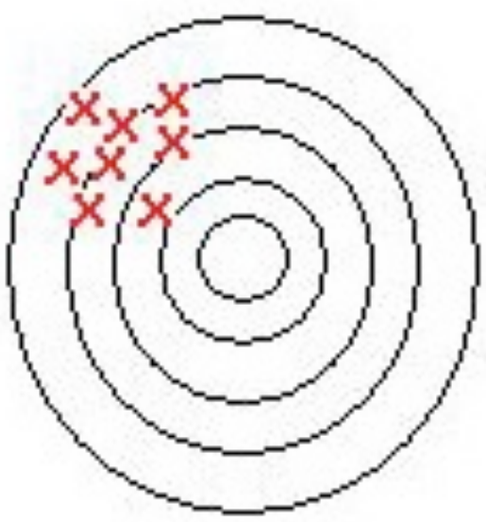
Look for ***ANY*** effect that can have an influence on your results.

Divide your data in any way you can (space, period, condition, analysis, etc.).

Large statistical error
Small systematic error



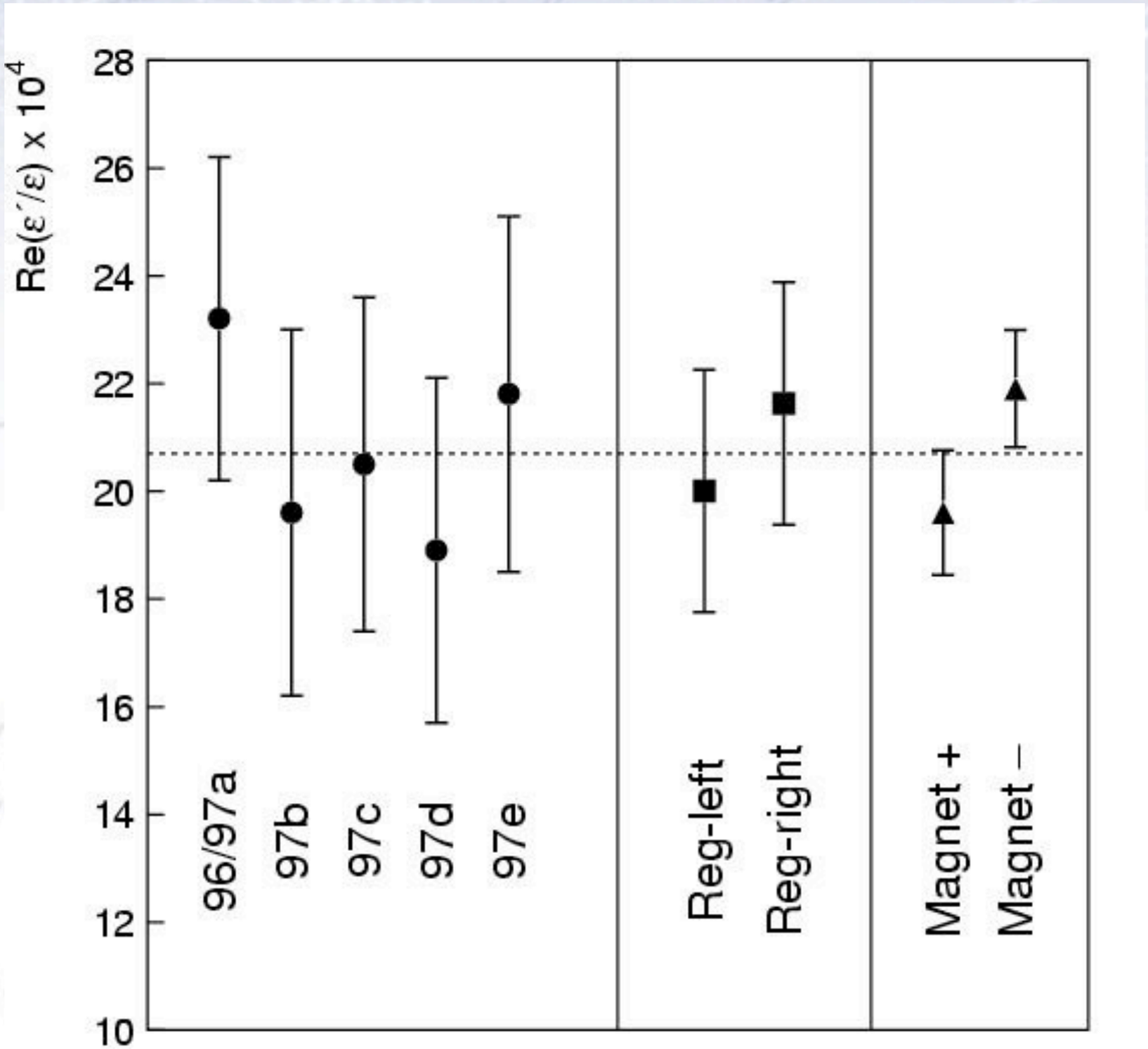
Small statistical error
Large systematic error



Medium stat. error
??? syst. error

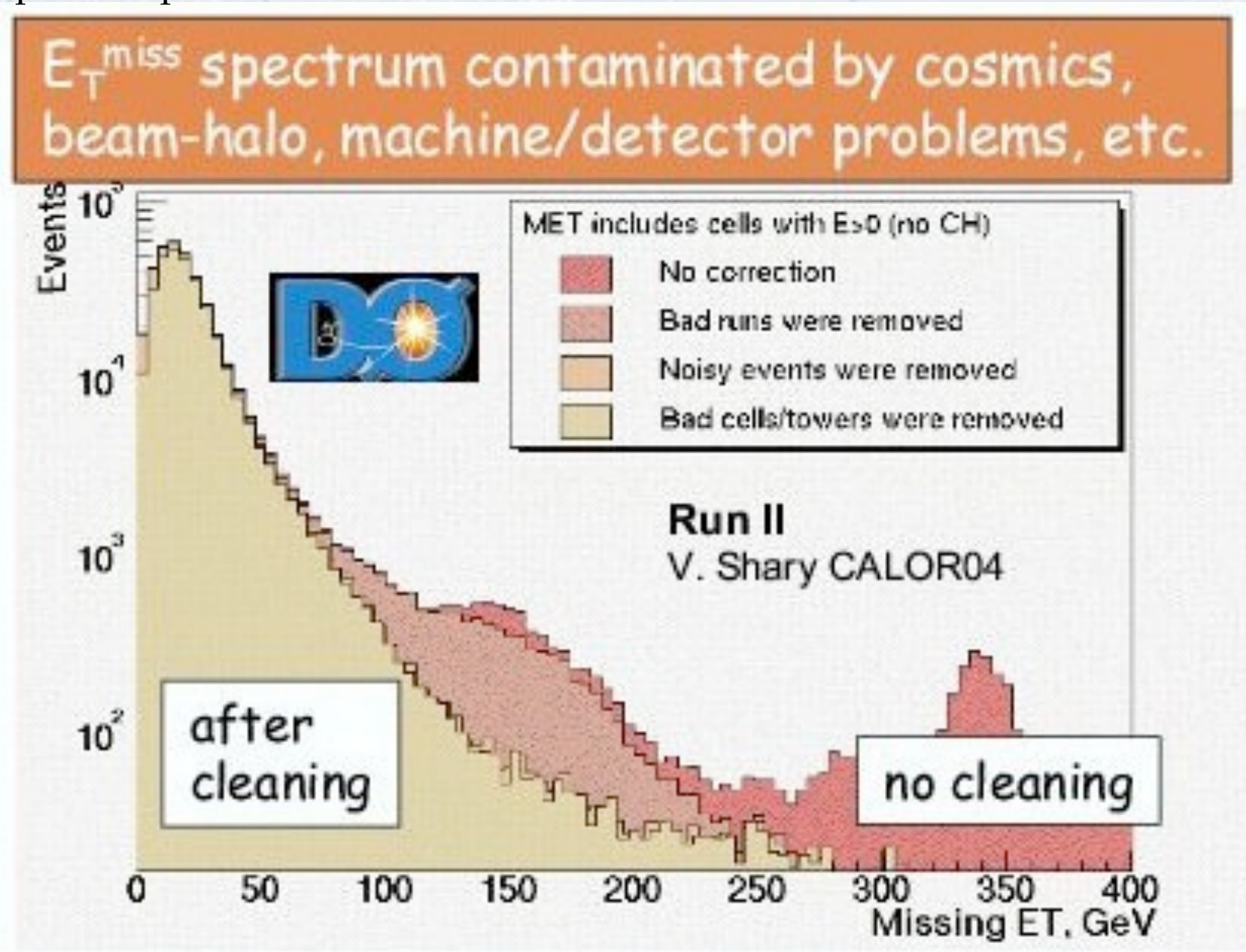
Often, systematic errors are studied using simulation. However, this requires that the simulation is accurate! To check this, one studies known phenomena.

Cross check of data



Systematic Error

Example of experimental error, which would be a disaster if not corrected for.



The good experimenter

The good experimenter

The good experimenter will always:

- inspect data visually.
- test assumptions.
- keep an accurate record.
- perform cross checks.
- do a ChiSquare test (also).
- plan the experiments carefully.

The good experimenter will never:

- rely on untested assumptions.
- “just let someones program do it”.
- make changes in data.
- look for only some effects.
- not look at the raw data.