

How to write a lab report

Name of lab exercise

Name of student(s)
Supervisor: Super Visorsson
Course name,
Lund University

Lab: Day Month, Year
Hand in: Day Month, Year

Contents

1	Introduction	3
2	Theory	4
2.1	Who are you writing for?	4
2.2	Moral aspects	4
3	Experimental setup and method	5
3.1	Layout and language	5
4	Results	5
5	Discussion	5
6	References	6

1 Introduction

A good lab report should have a theme throughout the text and the different sections — it needs to *tell a story*.

Our curiosity is often triggered by an observation. To explain an observed phenomenon, and to put it in a larger context, we construct a theoretical model within a mathematical framework. This theory can be tested by performing an experiment which can measure the quantity described by the model. Results are obtained by the measurement that needs to be interpreted. It is important to question these results, and to repeat the experiment in order to trust them; the experimental setup itself can introduce errors in the measurement so that the results can be misleading – and lead to an inaccurate interpretation – if the systematic effects are not corrected for. If the results are unexpected with respect to the theory, either the theory needs to be modified, or the experiment is unable to measure the quantity accurately. All this is summarized in Fig. 1, where the feedback loop is crucial to follow in order to present trustable results.

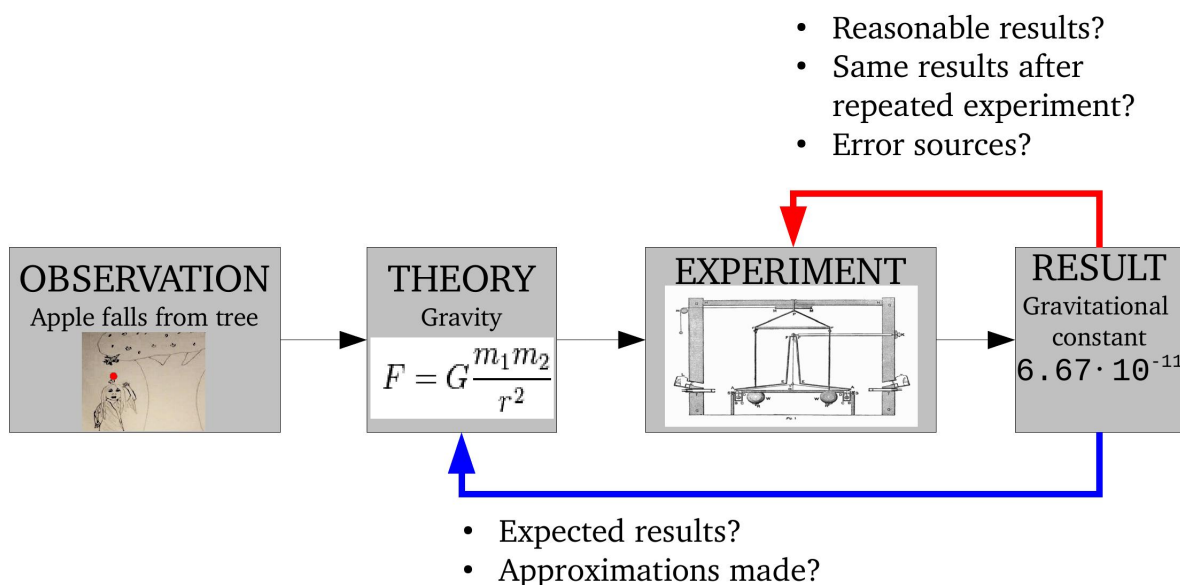


Figure 1: How science is done: the story from observation to experimental results.

A lab exercise is usually mirroring this structure: the purpose is of course to teach the student something about a physics topic by studying the theory of the topic, setting up an experiment that can measure the interesting quantities, and interpret the results (and hopefully confirm the theory). Therefore, the lab report should also mirror the observation-theory-experiment-result structure, and tell this story.

The goal and purpose of the exercise are described in the introduction¹, and the questions or problems are placed in a larger context. Before you start writing, think about the questions that should be answered in the report – it is often enough if you formulate these questions to yourself, you don't have to bullet list them in the report, but it will be a help if in doubt what to include and

¹This document is a summary of the student exercise "How to write a good labreport", therefore the student suggestions are in bold, while the rest can be seen as "teachers tips".

what not to include: do not include a section of text where the content is not directly connected with the story you are telling, and the questions you want to answer.

2 Theory

It is important to have a section **containing any relevant theoretical background needed to understand the methods and results of the experiment**, i.e. both the theory of the physics to be studied, and the theory behind the experimental equipment used to perform the experiment. **This will tell the reader what results to expect from the measurements.** Here follows some instructions concerning variables and formulas:

- **Variables should be in italic**, e.g. η , Σ , p , or d
- Vectors should be both italic and bold, or italic with a vector sign, e.g. $\mathbf{p}$, or $\vec{p}$
- **Define the variables you use (needs to be done only once)**, e.g. "where $\vec{p}$ is the momentum of the electron"
- **Numbers and units are written in normal fonts**, e.g. 126 GeV, or 7 m
- **Number the important equations to be able to easily refer to them in the text**, e.g.

$$F = G \frac{m_1 m_2}{r^2} \quad (1)$$

2.1 Who are you writing for?

It is difficult to know where to put the level of your text, but a general rule is to **write the report such that a person with similar physics background can understand, and it should be detailed enough so that a person with the same knowledge — or *you* two years later, if you are the new supervisor! — can repeat the experiment.** The second general rule is to write the report in such a way that the supervisor correcting your report understands that you have understood the content of the lab.

2.2 Moral aspects

Often when you write the theory section you take a look in the course material or at the Internet for guidance, but remember that you still need to **formulate the text in your own words; it is *strictly not allowed* to copy material.** If you quote an equation or learn relevant information from e.g. the course book, a reference is needed. To refer to a book, article, lab manual, or web site, the list number of your reference is stated in square brackets. The supervisor often uses Urkund[1] to check the report for plagiarism.

If you are writing a report in a group, it is important that all members of the group are active.

3 Experimental setup and method

The experimental setup is ideally described along with a figure of flow chart type. The measurements and calculations should be explained in such way that someone else with similar knowledge can reproduce the same experiment. It is important to estimate the systematical errors of the experiment and show them along with the results in the result section.

3.1 Layout and language

Here follows a short summary of the general layout and language of the whole report. The language should be academic and objective, and be written in the same tense throughout the report. Often no personal pronouns are used. Make sure you run your text through a spelling program before you hand it in, and correct grammar mistakes.

There is no exact rule of what font to use, or what size a header should be in, but there is one important rule: the layout should be consistent! This means that the headers should use the same font and size, the text should have the same appearance, there should be page numbering and numbers on figures, tables, and equations, so that it is easy to refer to them in the text. If you are collaborating it is especially important to make sure that the contributions from the different authors fit together in a consistent way. A practical tool for scientific writing is L^AT_EX[2]. It is a typesetting system which include features designed for producing a technical and scientific document, it automatically keeps track of sections, numbering and a consistent style. Almost all scientific publications are written in L^AT_EX. With this document follows the text-file that is used to produce the pdf-file. You are free to use it as a skeleton for your reports. All you need to do is to download a L^AT_EX compiler and compile labreportExample.tex.

4 Results

This is the section where the results from the measurements are presented. Results are often presented in tables or in the form of a plot, i.e. a diagram or a graph showing the relevant observable. A diagram showing results from your measurements can be compared to a theoretical curve in the section for results, but the discussion of the interpretation comparing your results with theoretical models should be restricted to the discussing section. The figure should, however, always be mentioned in (and be relevant to) the text.

Figures and tables should have a title and be numbered so that it can be referred to in the text, and the table columns and axes in a diagram should be clearly labeled with observable name and units, where the variable comes first, and then, after a slash, the unit, e.g. $\lambda/\mu\text{m}$, or U/kV . The figure caption should contain a description of what is shown in the plot (so that the plot could be understood without reading the text), but no interpretations should be done in the caption, see example plot Fig. 2.

5 Discussion

The discussion is the most important part of the lab report and should not be rushed over. This is where you interpret your results and compare to theory: are your results expected? Connect

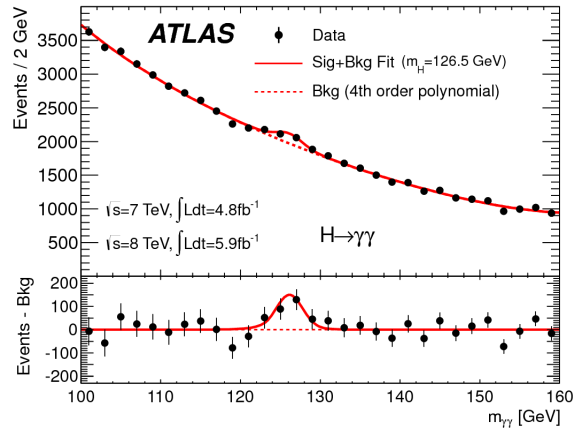


Figure 2: The distributions of the invariant mass of diphoton candidates for the combined 7 TeV and 8 TeV collision data sample, showing a peak at $m_H = 126.5$ GeV. The residuals of the data with respect to the respective fitted background component are displayed in the ratio. Figure from [3].

it to the purpose you had in the introduction: is the goal fulfilled? While the sections in the report are detailed, the discussion and introduction should focus to the larger picture.

The experimental method and error sources can also be discussed here as an evaluation of the quality of the experiment. But **no new information should be introduced, either concerning experiment or theory**. Could anything have been done differently? How would the results and errors be affected if the experiment were performed under different circumstances (e.g. a longer measurement)?

Remember that a discussion about error estimation is not a listing of unknown factors, but a thorough well thought out discussion of what factors could noticeably affect the results.

One last tip: always convert your report to pdf!

6 References

There are different systems of writing references, you need at least the author, title, and release date (or search date). You can read more about this at

<http://www.ub.umu.se/skriva/skriva-referenser/vanliga-referenssystem>, or

<http://www.ub.umu.se/en/write/references/common-reference-systems> for english.

1. <http://www.urkund.se/> (10 Feb, 2014)
2. <http://www.latex-project.org/> (10 Feb, 2014)
3. The ATLAS Collaboration, *Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC*, Phys.Lett. B (31 Aug 2012), arXiv:1207.7214v2