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A Dissertation Presented to the Graduate Faculty of the  
Dedman College  
Southern Methodist University  
in  
Partial Fulfillment of the Requirements  
for the degree of  
Doctor of Philosophy  
with a  
Major in Physics  
by  
Graduate Student

B.S., Physics, Undergraduate University  
M.S., Physics, Southern Methodist University

May 1, 2019

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## ACKNOWLEDGMENTS

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M.S., Physics, Southern Methodist University

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Advisor: Dr. Advisor Name

Doctor of Philosophy degree conferred May 1, 2019

Dissertation completed January 1, 2019

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## PREFACE

The following is a summary of useful concepts in high energy particle physics.

### **0.1. Units**

Discussion of units

### **0.2. Coordinates**

[Large Hadron Collider \(LHC\)](#) coordinate systems

### **0.3. Statistics**

Statistics in particle physics

## CHAPTER 1

### Introduction

This is the first chapter of the [thesis](#). [1,2]

#### 1.1. Creating Figures

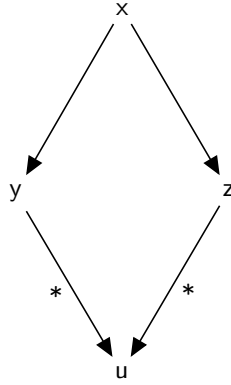


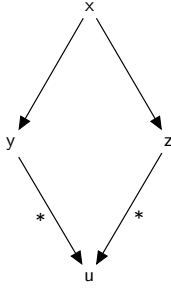
Figure 1.1: This is a placeholder figure to act as an example. Here we cite a new reference in the caption to demonstrate that given the package configuration our order of references will not be distributed by the table of contents [3].

As can be seen in Figure [1.2](#), the subfigures are independent of each other such that Figure [1.2a](#) and Figure [1.2b](#) can be accessed separately.

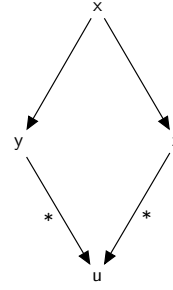
As an example of an equation formatted in “[display style](#)” the equation for the fiducial cross section from [1] is reproduced as Equation [1.1](#):

$$\sigma_{\text{inel}}^{\text{fid}}(\zeta > 10^{-6}) = \frac{N - N_{\text{BG}}}{\epsilon_{\text{trig}} \times \mathcal{L}} \times \frac{1 - f_{\zeta < 10^{-6}}}{\epsilon_{\text{sel}}} \quad (1.1)$$

#### 1.2. Creating Tables



(a) This is the first figure of two, in this example, and its own independent subfigure.



(b) As the `t` alignment option was chosen for the subfigures, they are still properly aligned vertically even though this caption is longer.

Figure 1.2: An example of a figure that consists of two subfigures.

To create tables in  $\text{\LaTeX}$  it is highly recommended to use the [booktabs](#) package. It allows for very elegant and clean table creation, such as Table 1.1. If you want to create a table quickly, or have a CSV file that you'd like to quickly turn into a table there are various [online  \$\text{\LaTeX}\$  table generators](#).

Table 1.1: Common quantities in particle physics given in both natural units and SI units.

Quantity	Natural Units	Natural Units (dimensionful)	SI Units
Speed	1	$c$	$3.0 \times 10^8 \text{ m/s}$
Angular Momentum	1	$\hbar$	$10^{34} \text{ m}^2 \text{ kg/s}$
Energy	GeV	GeV	$1.6 \times 10^{-10} \text{ J}$
Momentum	GeV	$\text{GeV}/c$	$1 \times 10^{-19} \text{ kg m/s}$
Mass	GeV	$\text{GeV}/c^2$	$1.8 \times 10^{-27} \text{ kg}$
Time	$1/\text{GeV}$	$\hbar/\text{GeV}$	$6.6^{-25} \text{ s}$
Length	$1/\text{GeV}$	$\hbar c/\text{GeV}$	$2 \times 10^{-16} \text{ m}$
Electric Charge	1	$e/\sqrt{4\pi\alpha_{\text{em}}}$	$5.3 \times 10^{-19} \text{ C}$
Magnetic Field	$(\text{GeV})^2$	$(\text{GeV})^2/\hbar c^2$	$5 \times 10^{16} \text{ T}$

Good table design requires some thought and work, so it may be worth a look through some examples:

- [TeX StackExchange: Tip on how to make a visually good table](#)

- [Edward Tufte endorsed](#) example from [Darkhorse Analytics](#)

### 1.3. Dealing with Widows and Orphans

To reduce the difficulty of dealing with widowed text (the last line of a paragraph at the start of a page) and orphaned text (the first line of paragraph at the end of a page) the `nowidow` package is used. However, that doesn't solve the issue of orphaned section titles. The user must manually do this, but the following [simple advice from T<sub>E</sub>X FAQ](#) is recommended:

Once you've exhausted the automatic measures, and have a final draft you want to "polish", you should proceed to manual measures. To get rid of an orphan is simple: precede the paragraph with `\clearpage` and the paragraph can't start in the wrong place.

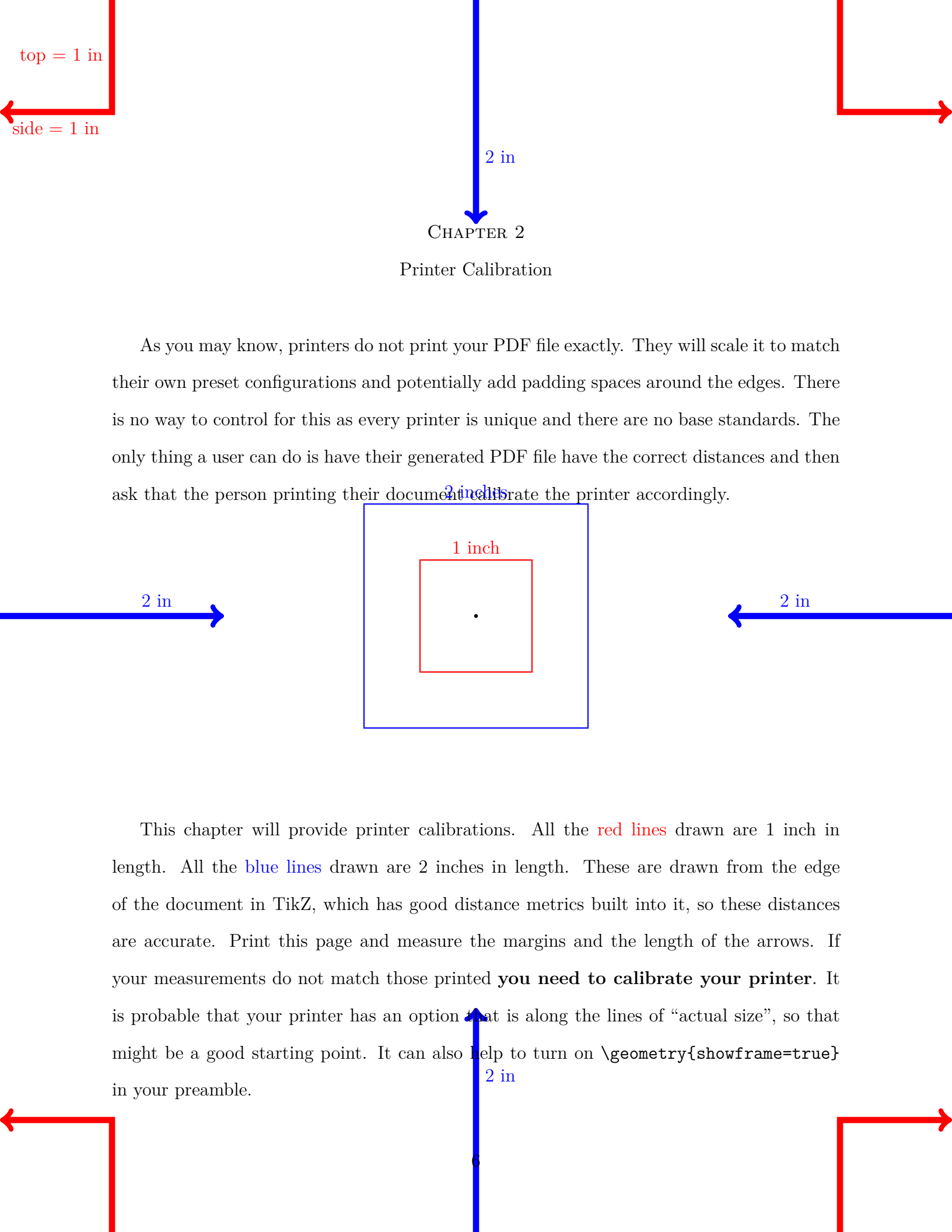
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As you may know, printers do not print your PDF file exactly. They will scale it to match their own preset configurations and potentially add padding spaces around the edges. There is no way to control for this as every printer is unique and there are no base standards. The only thing a user can do is have their generated PDF file have the correct distances and then ask that the person printing their document calibrate the printer accordingly.

This chapter will provide printer calibrations. All the red lines drawn are 1 inch in length. All the blue lines drawn are 2 inches in length. These are drawn from the edge of the document in TikZ, which has good distance metrics built into it, so these distances are accurate. Print this page and measure the margins and the length of the arrows. If your measurements do not match those printed **you need to calibrate your printer**. It is probable that your printer has an option that is along the lines of “actual size”, so that might be a good starting point. It can also help to turn on `\geometry{showframe=true}` in your preamble.



## APPENDIX A

### An Appendix

Appendix text goes here.

## GLOSSARY

**Large Hadron Collider (LHC)** Large Hadron Collider. [viii](#), [1](#)  
**thesis** <https://xkcd.com/1403/>. [2](#)

## BIBLIOGRAPHY

- [1] ATLAS collaboration, M. Aaboud et al., *Measurement of the Inelastic Proton-Proton Cross Section at  $\sqrt{s} = 13$  TeV with the ATLAS Detector at the LHC*, *Phys. Rev. Lett.* **117** (2016) 182002, [[1606.02625](#)]. [2](#)
- [2] O. S. Brüning, P. Collier, P. Lebrun, S. Myers, R. Ostojic, J. Poole et al., *LHC Design Report*. CERN Yellow Reports: Monographs. CERN, Geneva, 2004. [2](#)
- [3] P. W. Higgs, *Broken symmetries, massless particles and gauge fields*, *Phys. Lett.* **12** (1964) 132–133. [viii](#), [2](#)