1 Introduction

In this thesis we are interested in a specific aspect of theoretical high energy physics. In particular, the topic of interest is that of electron-positron (e^+e^-) collisions. As is typical in physics, the equations that govern the interactions are quite complicated and it is almost impossible to find exact solutions, so all functions of interest are perturbatively expanded, meaning they are expanded in a power series of a small parameter. When the force in question is the electromagnetic interaction, one can simply use the fine structure constant (or electromagnetic coupling constant) $\alpha_{em} \sim \frac{1}{137}$.

When discussing particles that interact with the strong interaction, it is then natural to use the strong coupling constant α_S. The function we are interested in is the Thrust differential cross section. We are able to calculate it to the first order, but when discussing higher order corrections, one must include radiative corrections, meaning one must consider the emission of additional soft gluons. These corrections lead to logarithmically enhanced terms such as $\alpha_S \log(M/qT)$, where M is the mass of the final system and qT is the transverse momentum. For small qT , where the bulk of events is produced, $\log(M/qT)$ can become quite large, but when $\alpha_S \log(M/qT) \sim 1$ the perturbative expansion becomes meaningless because the neglected terms can be of the same order of the included terms.

In order to obtain realistic cross sections, these logarithmically enhanced terms must then be treated differently. A promising solution is the theory of resummation[1]: instead of stopping at a certain power of α_S as in standard perturbation theory, we calculate an all order resummation of the $\alpha_S \log(M/qT)$ terms which lead to a consistent exponential term, the Sudakov form factor. It turns out that the Sudakov form factor itself is a power expansion of α_S but now with no logarithmic enhancement. The first order calculation is called Leading Logarithmic

(LL) order, the next order calculation is called Next to Leading Logarithmic (NLL) and so on. In the literature, it has been calculated up to N3 LL. We were able to calculate the next order, N4 LL, and the main objective of this thesis is to estimate the uncertainty in this function due to the missing higher order corrections. In the first chapter we introduce the forces and particles of the Standard Model, also describing the Quantum Field Theory formalism which is at the base of all the forces described in the Standard Model. In the second chapter we then describe the process of interest and illustrate the theorems and formulas necessary to calculate the relevant cross sections. In particular we introduce the resummation formalism and the Sudakov form factor which is the main object of this work. In chapter 3, we describe the calculations that lead us to obtain the Sudakov fom factor at different logarithmic orders and finally in chapter 4 we present plots of this function and discuss its uncertainty, first using the standard methods and then exploring different methods.