Hitchhiker's guide to this thesis

I love deadlines. I like the whooshing sound they make as they fly by. **Douglas Adams**

In your hands lies a compilation of 5 years of work done with many "hard" deadlines, all of them respected. But one deadline seemed to whoosh by: the one for this work.

There are two main parts to this volume. Part I describes the experimental apparatus of NA60 in several of its incarnations both with proton and ion beams in the years 2002, 2003 and 2004, while Part II develops the physics analysis of the dimuon intermediate mass region of NA60 in indium-indium collisions at 158 GeV per nucleon. We have made an effort in keeping chapters succinct; whenever detailed information had been previously published we defer it to the appended matter, sometimes in the form of full publications where I am one of the main authors.

The first part starts by introducing the experimental concept of NA60 and presenting each of its sub-detectors and elements in chapter 1, starting on page 11. In particular, we overview the beam tracker, go through the vertex tracker, the zero-degree calorimeter, the hadron absorber and the muon spectrometer.

Chapter 2 (page 25) develops on the detector at the heart of the ion runs of NA60: the radiation-tolerant silicon pixel vertex tracker providing micrometer precision tracking of the hundreds of charged particles produced in the angular acceptance of the muon spectrometer. This chapter is complemented by Appendix A (page 121), where many hardware performance and technology related issues are discussed.

For proton running, the granularity of pixels is not required and pixels were indeed not the first vertex tracker used in NA60. In chapter 3 (page 31) we present the silicon microstrip vertex tracker and associated readout electronics as used in the proton-nucleus runs of 2002 and 2004.

The many ways raw data proceeds from on-detector electronics, to off-detector electronics, to central storage are described in chapter 4, starting on page 41). Further in-depth information on the software architecture used and on the versatile PCI readout electronics developed by and used in NA60 can be found in Appendix B, from page 139 onwards.

Closing the experimental part, we focus on the 25-year old dimuon trigger concept, the crucial element contributing to the collection of the enormous statistics of dimuons of NA60. In chapter 5 (page 47) we overview this system and discuss a possible way of reimplementing it in a future experiment, using modern technology.

Once data-taking is finished, data analysis starts, and so does the second part of this work. We start by explaining (in chapter 6, page 59) the steps involved in data selection (with details given in Appendix C, page 197), the event reconstruction in both the muon and the vertex spectrometers, and the unique feature of NA60 in heavy-ion collisions: the matching of spectrometer muons to vertex tracks from the vertex tracker. In parallel, we illustrate the detector physics's performance at all levels.

With respect to previous dimuon experiments, NA60 has additional background contributions coming from the matching procedure and a much more involved treatment of the already known backgrounds, due to the introduction of a dipole field in the vertex region. In chapter 7 (page 75) we lay the foundations for the background subtraction in NA60, explain the options and algorithms used to implement it, and illustrate its accuracy using the IMR analysis as an example.

Finally, chapter 8 (page 95) presents and discusses the presence of an excess of events in the dimuon mass region between the ϕ and J/ψ peaks, in line with previous dimuon observations. To characterise this excess, we make use of the unique ability of NA60 to identify muons displaced from the interaction vertex. This leads to the conclusion that the excess is prompt in nature.

Beyond page 113 we summarise the results obtained in this work and venture into what the future could reserve.

Finally, all appended matter is collected after page 119.

Please note that throughout the text we use natural units, where $h = c = 1$.