INTRODUCTION

Statistical Quantum Chromodynamics predicts that, in nuclear matter under extreme temperature and/or energy density conditions, a deconfined state of quarks and gluons would be created : the quark gluon plasma (QGP). In ultra-relativistic heavy ion collisions, such extreme nuclear conditions should be reached and the deconfined phase should be characterised by the appearance of theoretically predicted signatures. An exploratory programme was thereafter started at the SPS at CERN, where 200 A GeV/c Oxygen ions were first accelerated in 1986, then followed by 200 A GeV/c Sulphur ions in 1987 and by 158 A GeV/c Pb ions from 1994 up to now. This programme, which main goal is the discovery of the deconfined plasma, also allows for a general study of the properties of hadronic matter as produced in nucleus-nucleus collisions.

The NA50 experiment at the CERN SPS studies the muon pair production in nucleus-nucleus collisions to probe the behaviour of nuclear matter under the aforementioned conditions. Since the dimuons generated in the interaction volume interact weakly with the hot surrounding medium, they can escape undisturbed and carry out informations about the state of the matter where they were generated.

The dimuon mass spectrum can be roughly subdivided in three main regions : the Low Mass Region (LMR) below the ϕ resonance, the Intermediate Mass Region (IMR) between the ϕ and the J/ψ and the High Mass Region (HMR) above the J/ψ. While the HMR is due to the superposition of dimuons from the DY process and from the leptonic decay of the J/ψ and ψ', dimuons in the LMR and IMR originate from different sources (hadron Dalitz decays, charmed meson semi-leptonic decays and DY) with individual shapes and relative contributions not immediately deducible from the data.

The combinatorial background, due to the combination of muons from pion and kaon decays, also gives a very important contribution in the intermediate and low mass regions. In particular, its contribution to the IMR opposite-sign mass spectrum can amount up to 85% in proton-nucleus and central 200 A GeV/c S-U collisions, and up to 95% in central Pb-Pb collisions. Therefore, in order to study the IMR dimuon sources and their behaviour with changing energy and centrality of the collision, the combinatorial background has to be subtracted in such a way that no doubt remains about the nature of the measured signal. The shape of the mass distribution of the opposite-sign combinatorial background is usually extracted from the experimental like-sign background distributions. The normalisation of the background contribution to the opposite-sign dimuon spectrum can also be extracted using the same methods, if we are dealing with interactions where the produced high particle multiplicities simulate the absence of charge correlation effects. When charge correlation effects can not be neglected, they have to be carefully estimated to eventually correct the background normalisation factor.

Experimental evidences exist that in nucleus-nucleus collisions at SPS energies the dilepton production in the low and intermediate mass regions is enhanced with respect to the expected yields as extrapolated from proton-nucleus results. This motivates the present study, where the IMR for the 450 GeV/c p-A(A=Al,Cu,Ag,W), 200 A GeV/c S-U and 158 A GeV/c Pb-Pb data sets is studied. The intermediate mass region is here assumed to be a superposition of dimuons from DY, charmed hadron decays and combinatorial background. In this thesis, the effect of the residual charge correlation effects on the background normalisation factor is studied with a specifically developed MC chain. Monte-Carlo techniques have been used to generate the DY and open charm mass, transverse momentum, rapidity and angular differential distributions. The Monte-Carlo generated mass distributions have then been used to fit the data in order to determine their relative contributions to the experimental opposite-sign mass spectra. Since the background contribution to the opposite-sign mass spectra is fixed with the calculated normalisation factors and the DY contribution is determined by the high mass region, where only DY muon pairs can be found, our approach corresponds to interpret the dimuon excess in the IMR as due to an enhanced open charm production.

In the first chapter of the present thesis, after a general overview of the physics of heavy ion collisions, the dimuon excess measured in the low and intermediate mass regions by the experiments CERES, HELIOS/3 and NA38/NA50 at SPS is discussed. In the same chapter, the physics of DY pair production and open charm hadro production process is detailed. Chapter 2 describes the NA38/NA50 experimental apparatus, whereas chapter 3 quickly outlines the method used to reduce the experimental data.

Chapter 4 details the Monte-Carlo techniques used to obtain the mass, transverse momentum, rapidity and angular differential distributions for all the processes contributing to the intermediate mass region. In chapter 5 I describe the Monte-Carlo chain specifically developed in order to compute the combinatorial background normalisation factors for each of the considered systems. This approach is new and different from the one adopted by the NA38/NA50 Collaborations in the past.

Chapter 6 details the analysis of the IMR of the 450 GeV/c pA, 200 A GeV/c SU and 158 A GeV/c PbPb systems. The acceptance corrected open charm and DY contributions for each of the studied systems are extracted by means of a fit of the corresponding mass spectra. This study is performed as a function of the centrality of the collision. As a result, the extracted open charm yield in nucleus-nucleus collisions is found to be enhanced with respect to QCD expectations.

In chapter 7 it is shown that the found open charm enhancement quadratically increases with the collision centrality. Since open charm hadro production is a hard process, and is therefore expected to linearly increase with the collision centrality, this result clearly indicates the existence of a new process for open charm production in nucleus-nucleus collisions. The results are then discussed in the light of the existing theoretical models.