Chapter 7

Conclusions

The present thesis deals with the measurements of photon multiplicity and pseudo-rapidity distribution as measured by a highly granular photon multiplicity detector (PMD) in the WA98 experiment carried out at CERN SPS. The PMD was a preshower detector made up of nearly 56,000 plastic scintillator pads, arranged in 28 box modules, covering a psedorapidity window spanning from 2.9 to 4.2. The scintillator pads were read out using a CCD camera system as used in the UA2 experiment. The first part of the thesis deals with all hardware aspects of the detector such as design, fabrication and performance tests both involving the test beam and the real experiments. The data presented here correspond to 158A GeV Pb ion induced interactions in Ni, Nb and Pb targets.

The minimum bias cross section for photon production for all the three targets as measured from the experiment have been found to be reasonably well explained by those obtained from the VENUS event generator (version 4.12). For lighter targets, corresponding to asymmetric collisions Pb + Ni and Pb + Nb, the experimental data
seemed to show a small hump in the high central region. For asymmetric high central collisions there is a certain range of impact parameters for which the lighter target could be considered to be totally inside the heavy projectile during the interaction leading to almost similar particle production. This mechanism may be considered to be resulting in a pile up. But with increasing impact parameter or decreasing centrality the overlapping volume/number of participants decreases leading to a drop in the cross section. This drop is later more than compensated by the increasing probability of peripheral collisions. This behaviour was also seen in the WA93 S+Au reactions at 200 A GeV [122].

The pseudorapidity distributions of photon production for the three targets were also studied vis a vis simulated data as obtained from VENUS. For high central events VENUS was found to underestimate the data by about 10% in all the cases. The peak of the pseudorapidity distribution was found to shift towards higher side in going from Pb to Ni targets as expected. Pseudorapidity density at the central rapidity as measured from various targets show a systematic increase with number of participants indicating a predictable behaviour which can be understood in simple geometrical considerations. This indicates nothing dramatic happening. Opening of a new degree of freedom is expected to lead to a sudden change which is not seen. However, the widths of the pseudorapidity distributions for different centralities for different targets were found to be very similar. The total photon yield was found to scale like $N^{1.13}_{\text{part}}$ once again showing no sudden change in behaviour with increasing particle density.

The mean transverse momentum $<p_T>$, of photons for Pb+Pb collisions as measured using the PMD $N_{\gamma}$ and MIRAC electromagnetic energy $E_T^{\gamma\mu}$, with increasing
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$P_{\text{max}}$, was found to show a small rise from $\sim 165$ MeV/c to a value $\sim 175$ MeV/c, which was nearly constant over the entire range again indicating no phase transition.

Finally the photon hit pattern from the Pb+Pd data, in a region of full azimuthal coverage ($3.5 \leq \eta \leq 4.0$), was analyzed for any possible azimuthal anisotropy or flow. Two independent methods \textit{viz.} the Fourier analysis method and the sub-event correlation method have been used for anysing the data. A small but finite elliptic flow has been observed. Results from VENUS+GEANT data analyzed in a simial manner also show a very small but non zero anisotropy which may be due to the correlation introduced from the decay of $\pi^0$s. Data show a higher anisotropy parameter compared to mixed and VENUS+GEANT results. The centrality dependence of elliptic flow was studied and the anisotropy parameter $v_2$ or $\alpha$ was found to decrease with increasing centrality as expected. The maximum elliptic flow was found to be about 0.08 for periferal collisions corresponding to $E_T$ in the range of 40 to 90 GeV (about 45%–65% of min bias cros section).