Inclusive e^+e^- Pair Production in pp Reactions at $E_{kin} = 2.2\,\mathrm{GeV}$ ◇

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We have investigated e^+e^- pair production in proton proton collisions with the HADES electron pair spectrometer at GSI Darmstadt. Measurements of e^+e^- pair yields from elementary reactions like $p+p$ provide an essential basis for comparison to heavy ion collision data. In addition, they will give physical information on electromagnetic properties of light hadrons and mesons involved in nuclear reactions in the few GeV energy regime.

The beam energy has been chosen to adjust the abundance of particular sources of the e^+e^- pairs. At incident energies close to or slightly below the η meson production threshold ($E_{kin} = 1.27\,\mathrm{GeV}$), the relative contribution of the still weakly known Δ dalitz decay ($\Delta \rightarrow Ne^+e^-$) to the full cocktail is comparatively strong. Measurements at energies between 1.3 GeV and 2.5 GeV allow a detailed study of the η dalitz decay ($\eta \rightarrow e^+e^-\gamma$), while contributions from ρ/ω-decays are still negligible. Since the η meson production cross section is very well known, these data can be used to calibrate the overall e^+e^- detection efficiency in the relevant momentum / mass region.

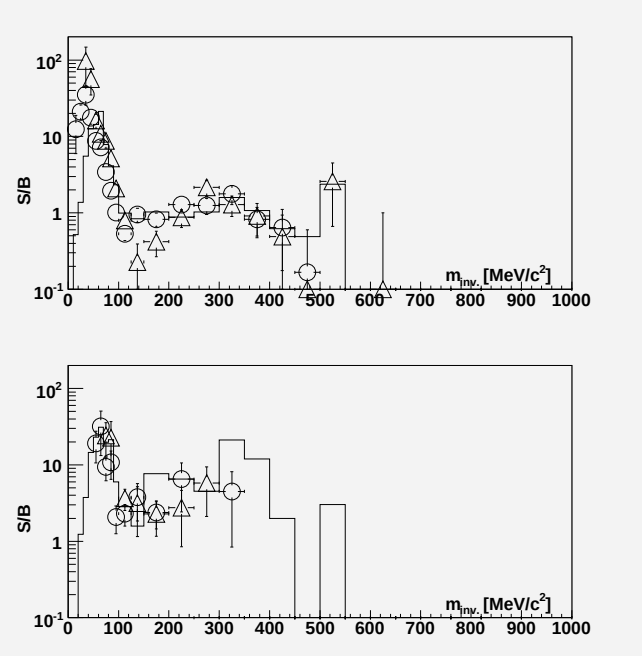

Fig. 1: Signal to background ratios (S/B) of e^+e^- pairs (exp: circles; sim: triangles) for tracks with (bottom) and without (top) vertex cut. The combinatorial background is calculated from likesign pairs in same events. The true S/B ratio (hist) is obtained from simulations.

We have performed a first $p+p$ run at $E_{kin} = 2.2\,\mathrm{GeV}$ by directing a beam of 10^7 protons/sec from the SIS to a liquid hydrogen target of 5 cm length. Hadron and e^+/e^- tracks were recorded for reactions with a minimum of 4 charged particles inside the acceptance of HADES. The data sample contains about 800 - 1000 net signal pairs in the inclusive e^+e^- invariant mass distribution above 200 MeV/c^2 (η-mass region). Due to the large geometrical acceptance the reaction channels $pp \rightarrow pp\eta \rightarrow pp\pi^+\pi^-\pi^0$ and $pp \rightarrow pp\eta \rightarrow pp e^+e^-\gamma$ could also be reconstructed exclusively via missing mass techniques.

Simulations based on the PLUTO event generator [1] and a full HGEANT spectrometer description [2] allowed to pin down accidental γ-conversion in detector support structures. Close pairs from this source dominate the combinatorial background and could be suppressed effectively with appropriate cuts on the vertices of e^+e^- track pairs. The obtained signal to background ratio and the effect of the vertex cuts is depicted in Fig. 1.

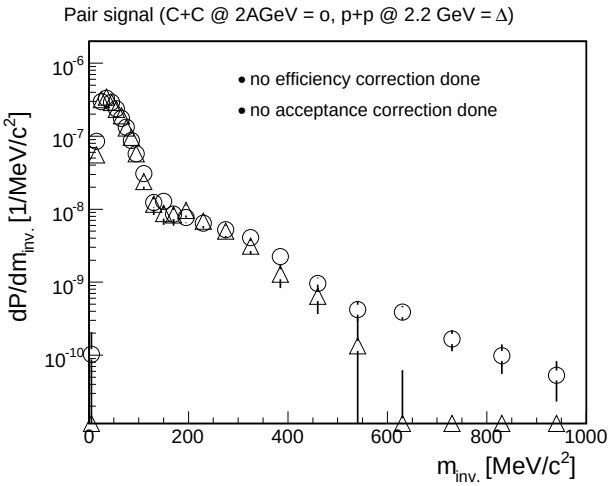

Fig. 2: Invariant mass distribution of e^+e^- pairs from $p+p$ reactions at $E_{kin} = 2.2\,\mathrm{GeV}$ (*open triangles*) and from $C+C$ reactions at $E_{kin} = 2.0\,A\mathrm{GeV}$ (*open circles*).

Fig. 2 shows the resulting inclusive e^+e^- invariant mass distribution. The data are compared to an earlier $C+C$ experiment performed at $E_{kin} = 2.0\,A\mathrm{GeV}$ [3]. The $p+p$ data have been scaled such as to obtain an equal number of detected signal pairs in the invariant-mass-region $0\,\mathrm{MeV/c^2} < m_{inv} < 150\,\mathrm{MeV/c^2}$ which is dominated by the π^0 dalitz decay $\pi^0 \rightarrow e^+e^-\gamma$. Within the error bars, yields and shapes of both mass distributions agree well up to the η mass. In contrast to the heavy ion data and in spite of the higher collision energy, the experimental spectrum of the elementary $p+p$ reaction does not show any significant contribution from the ρ/ω vector mesons.

While the data analysis is ongoing, we will conduct a new $p+p$ run at $E = 3.5\,\mathrm{GeV}$ in spring 2006 with focus on the ρ/ω mass region and substantially increased statistics (factor 10) in the η region.

References

[1] http://www-hades.gsi.de/computing/pluto/html/PlutoIndex.html
[2] http://wwwasd.web.cern.ch/wwwasd/geant/index.html
[3] R. Holzmann *et al.*, contrib. to QM2005

◇ supported by MLL, BMBF and GSI