PHENIX prompt e^+e^- pair continuum in $p + p$ collisions

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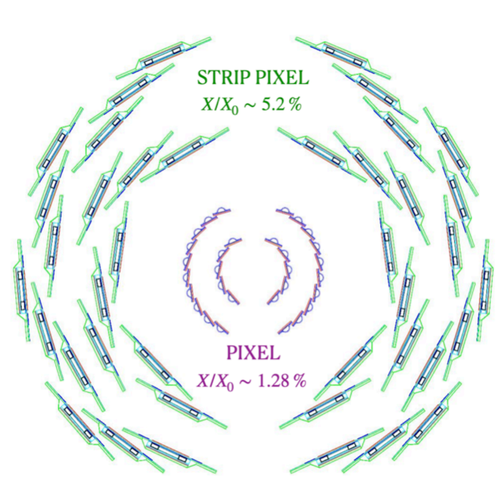
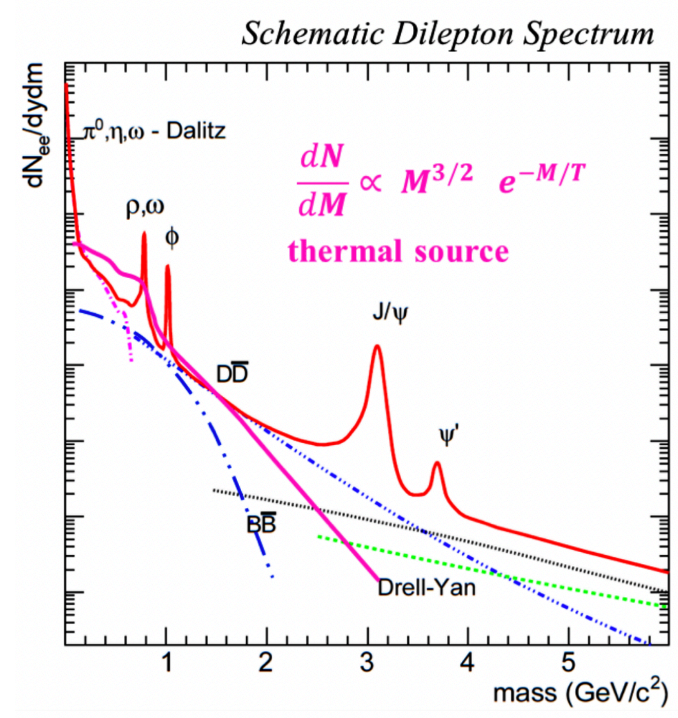
In this poster, PHENIX presents a proof of principle study for the measurement of prompt and non-prompt e^+e^- pair production in the intermediate mass range ($m_\phi < m_{ee} < m_{J/\psi}$) using $p + p$ data at 200 GeV taken in 2015. PHENIX plans to extend the measurement to the high statistics Au+Au data-set recorded in 2014 and 2016, with the goal to isolate the expected prompt thermal contribution in the intermediate mass region from non-prompt pairs from heavy flavor decays. In $p + p$ collisions the main physics signal in this mass region originates from semileptonic decays of charm and bottom $q\bar{q}$ pairs. These $e^+$and e^- origin from decays many micron away from the interaction point. This non-prompt component is identified statistically by measuring the distance of closest approach (DCA) with the PHENIX silicon vertex detector (VTX). The VTX has four layers with a total radiation length of about 15%, thus electrons from photon conversions cause a significant combinatorial background for the measurement, even in $p + p$ collisions. We have developed rejection techniques that effectively eliminate this background, improving the signal-to-background ratio by orders of magnitude. We will present the e^+e^- pair spectra from $p + p$ collisions and its non-prompt contributions.

INTRODUCTION

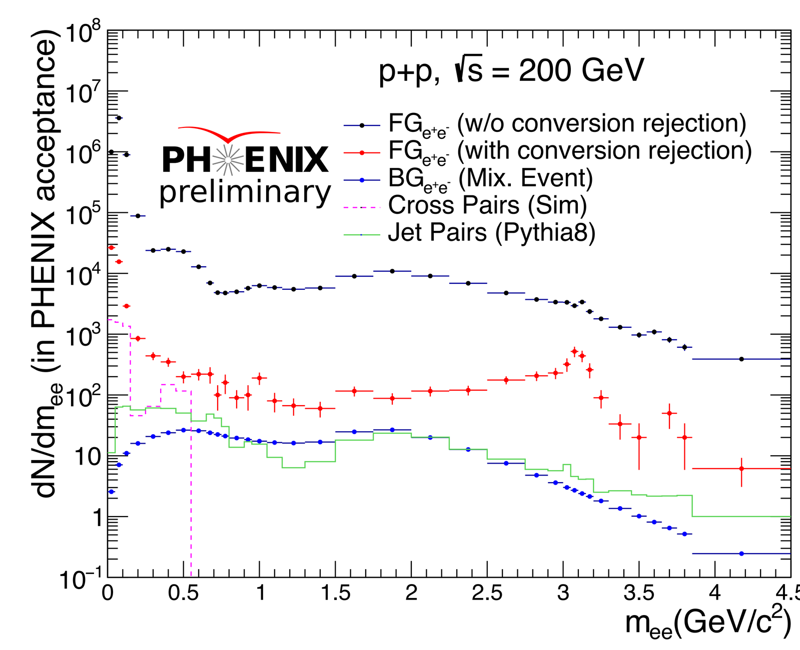
In relativistic heavy-ion collisions, the range, $m_\phi < m_{ee} < m_{J/\psi}$, is dominated by contributions from the thermal sources and semi-leptonic decays of open heavy flavor mesons.

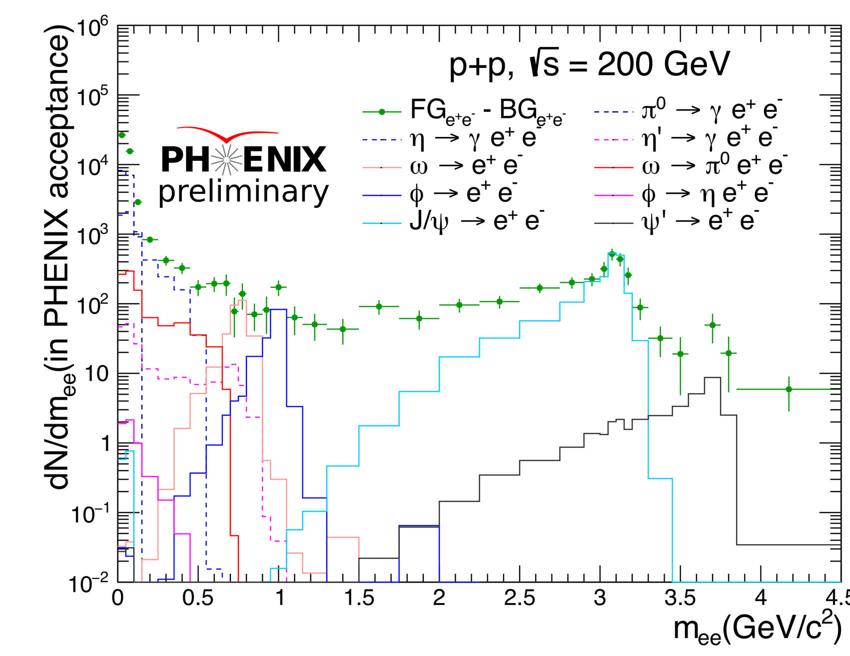


Radiation length of ~15% of the VTX detector imposes huge background from photon conversions.



MASS SPECTRUM

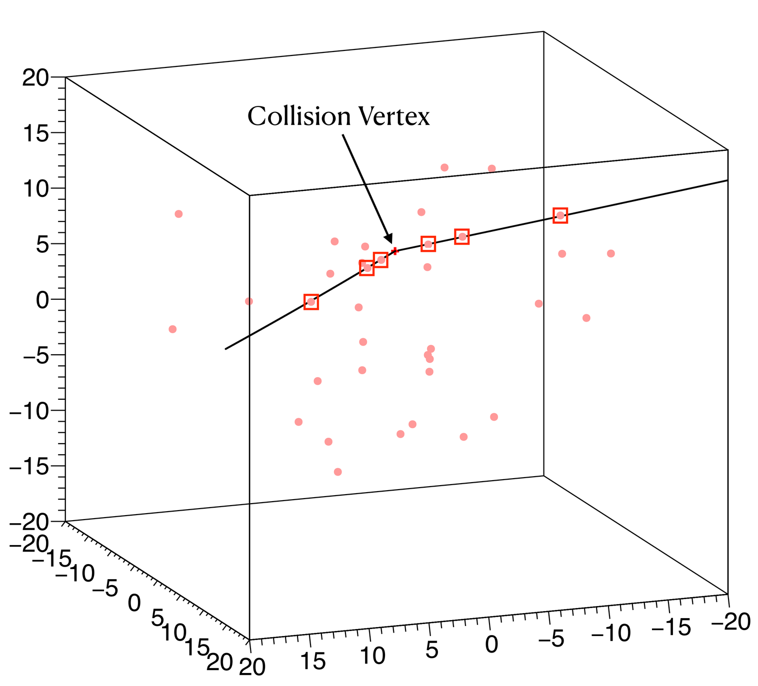




Minimal combinatorial background remains after effective conversion rejection.

Hadronic cocktail from the known sources is consistent with data.

TECHNICAL DETAILS

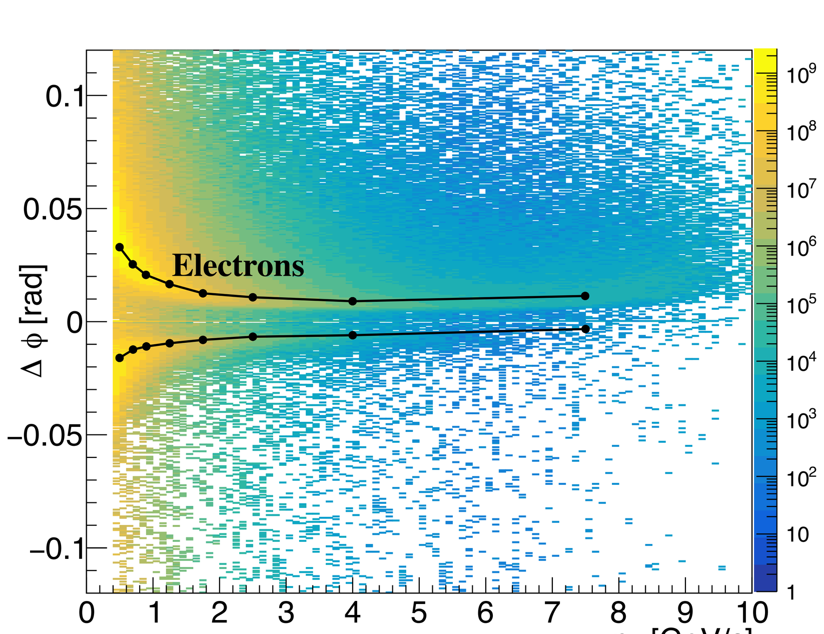


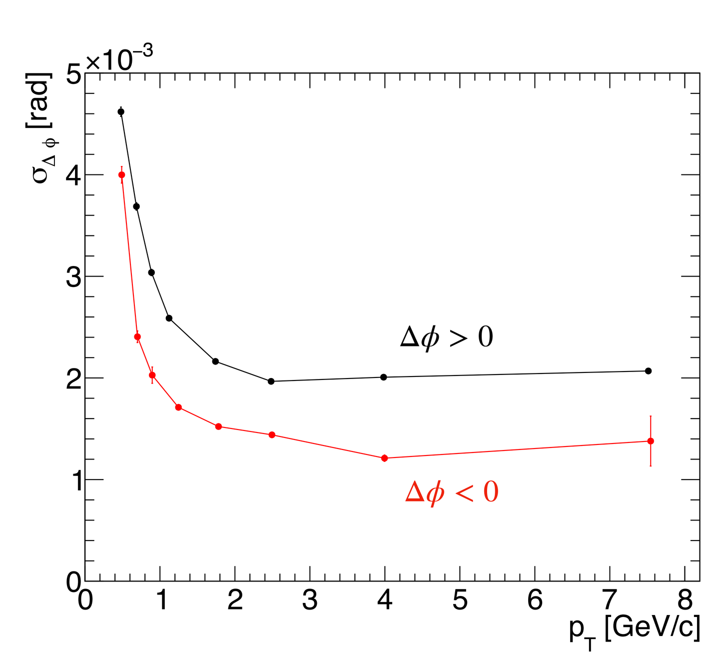
The track projections from the PHENIX Central Arm tracking are associated with the hits in the VTX layers for which Δd is minimum

$$\Delta d = \sqrt{\left(\frac{\phi^{proj}_{trk} - \phi^{hit}_{vtx}}{\sigma_\phi}\right)^2 + \left(\frac{\theta^{proj}_{trk} - \theta^{hit}_{vtx}}{\sigma_\theta}\right)^2}$$

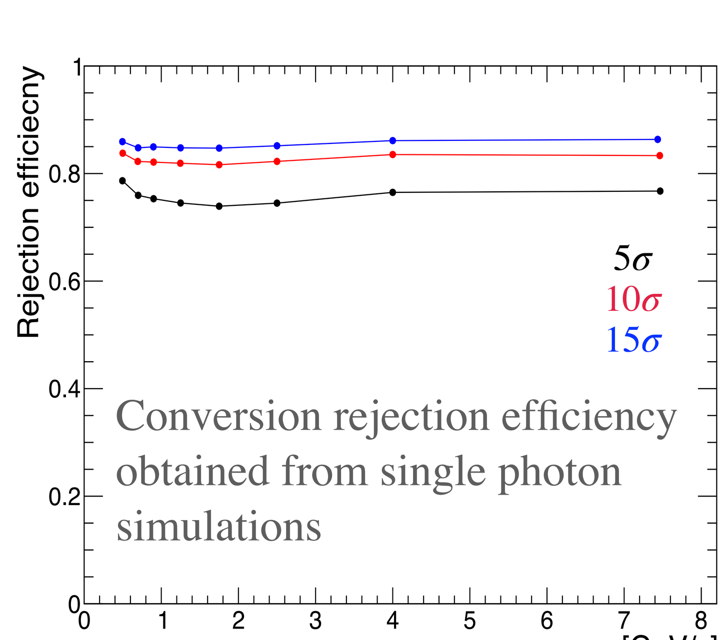
At least one hit is required in the inner and outer two layers of the VTX detector. This enables a DCA measurement and rejects ~80% of all photon conversions.

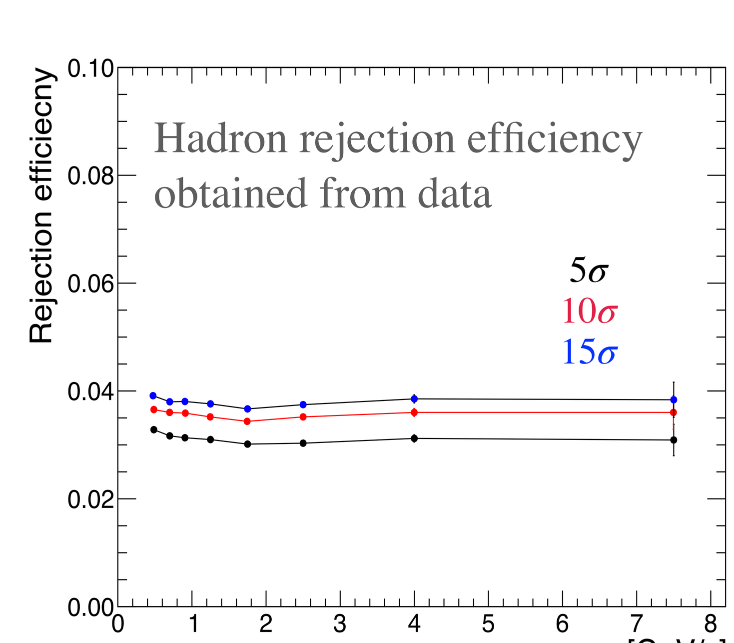
Additional ~50% rejection comes from searching for a neighboring hit in any of the four VTX layers within a 10σ window around the azimuth



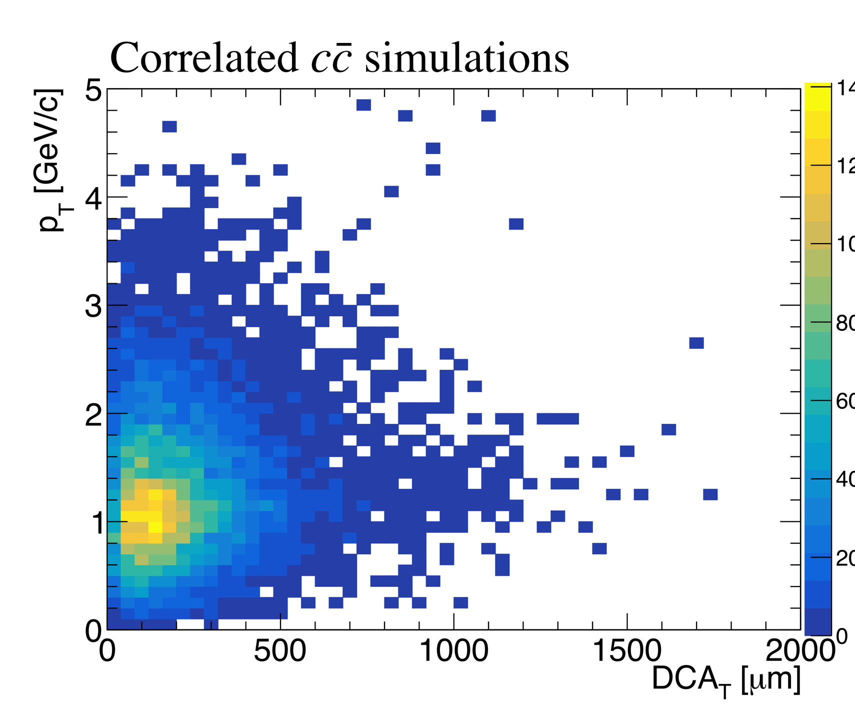


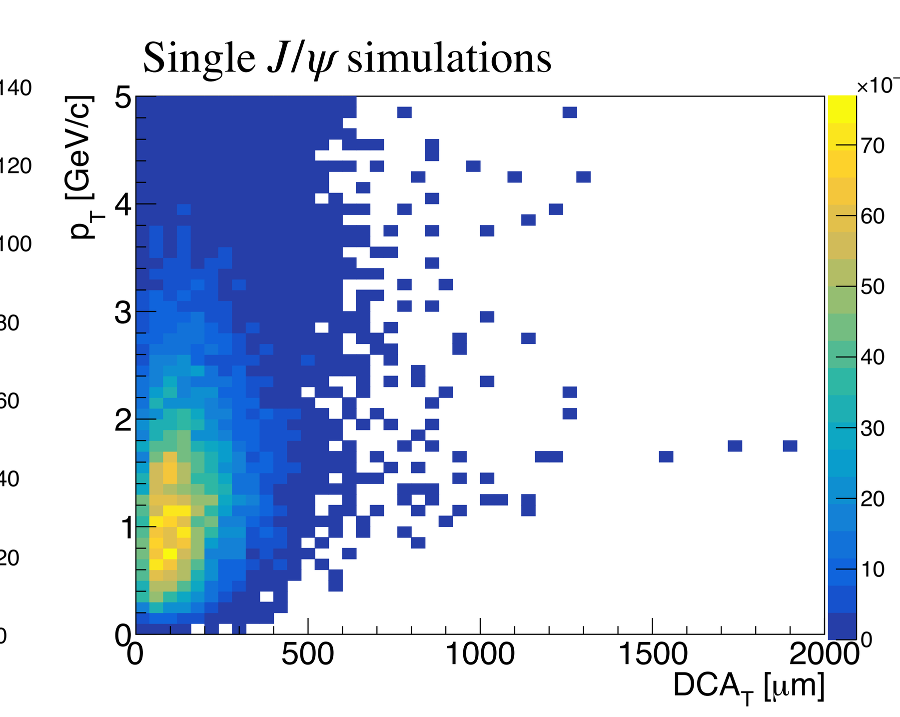
Mis-associated hits lie on the opposite side.





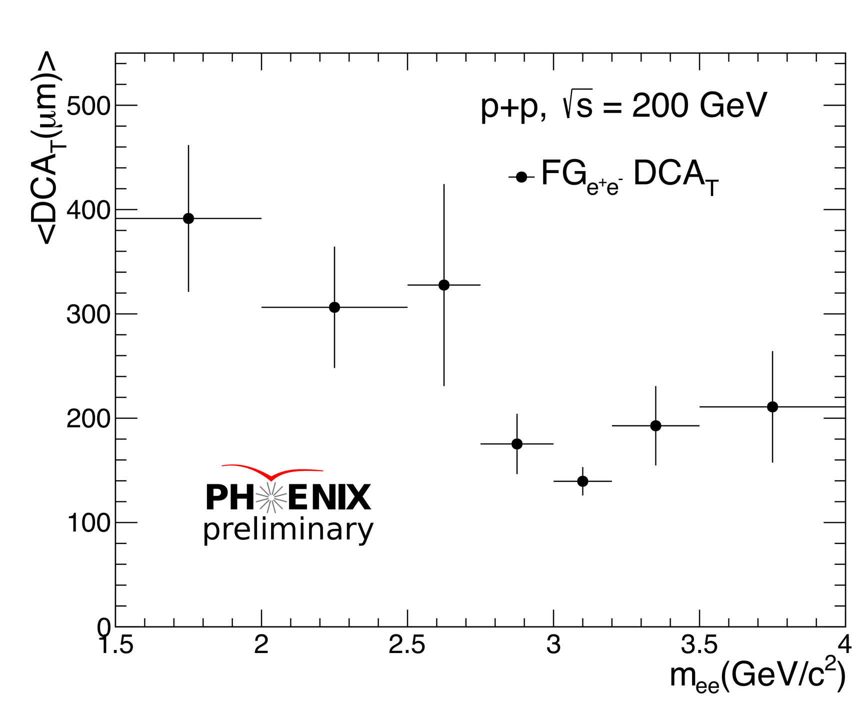
DCA MEASUREMENTS

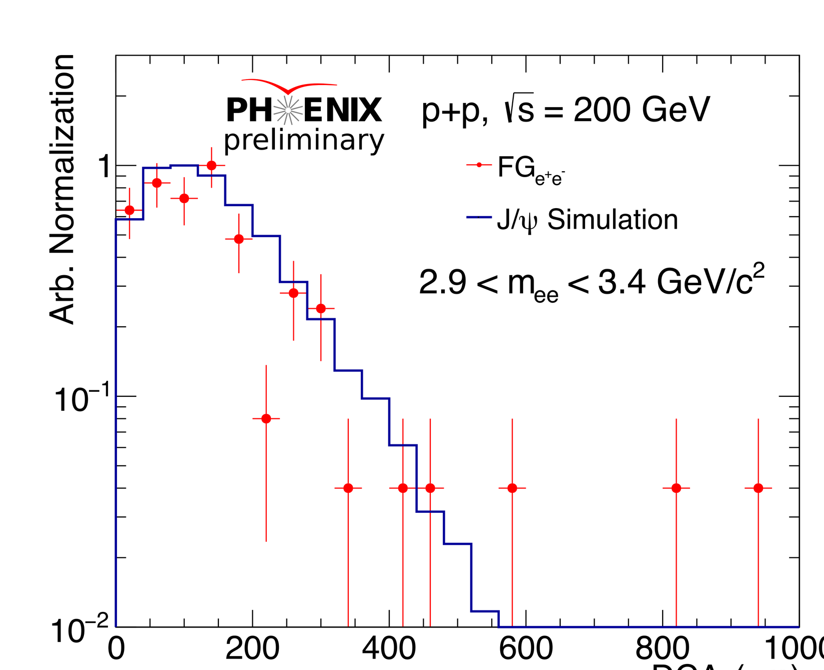




From single track DCA, e^+e^- pair DCA is given by

$$\sqrt{|DCA^2_{e^-} - DCA^2_{e^+}|}$$





Average pair DCA exhibits measurable variations as a function of pair mass

CONCLUSION AND OUTLOOK

The study presents a proof of principle that PHENIX can measure the dilepton pairs in the intermediate mass range and can separate the pairs from semi-leptonic decay and prompt pairs.

Next steps include investigating the feasibility of the measurement with the high-statistics data taken for Au+Au collisions at 200 GeV.