Low-mass Dielectron Production in p-Pb Collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE

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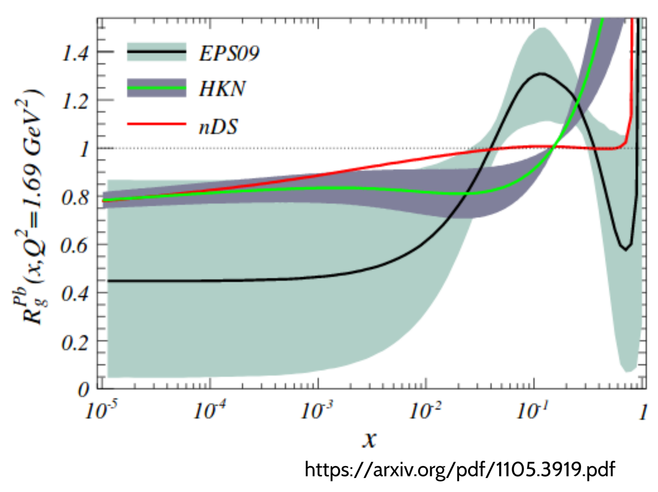
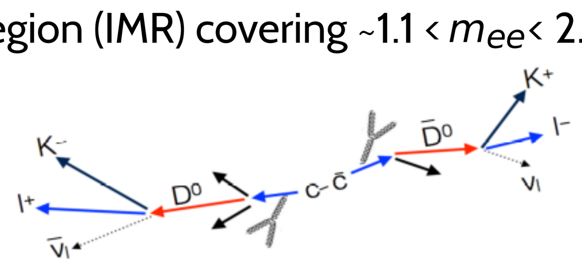
Correlated dielectron pairs are a very promising probe to study the quark-gluon plasma, a deconfined state of quarks and gluons predicted by lattice quantum chromodynamics calculations in ultra-relativistic heavy-ion collisions. Electrons reach the detector without significant final state interactions. In addition, the low-mass dielectron spectrum comes from various sources, i.e. Dalitz and resonance decays of pseudoscalar and vector mesons, semi-leptonic decays of charm and beauty hadrons, as well as the radiation from the thermalised system, which are produced at all stages of the collision. Therefore, dielectron pairs can be used to study the space-time evolution of the system. While pp collisions provide an important baseline measurement in vacuum for heavy-ion studies, p-Pb collisions can be used to disentangle cold from hot nuclear matter effects. Searching for the thermal signatures through dielectrons is also important in small systems to disentangle the initial and final state effects.

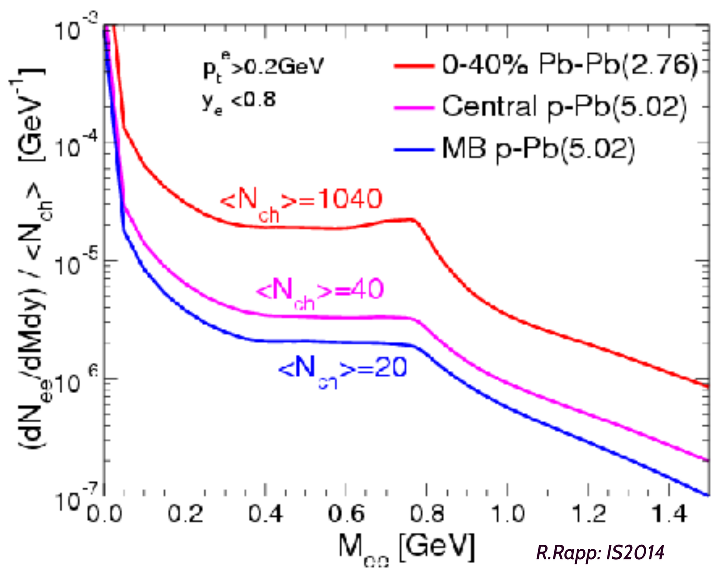
Theory Overview

- Nuclear Parton Distributions Functions (nPDF), in particular for gluons, can be studied with dielectrons by analysing semi-leptonic open charm and beauty decays. These decays are particularly dominant in the intermediate mass region (IMR) covering ~1.1 < m_{ee} < 2.5 GeV



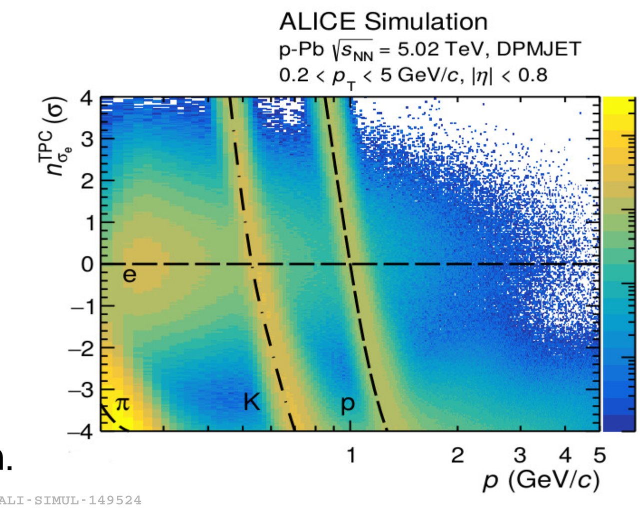


- Thermal modifications to the dielectron spectrum are predicted by Rapp. et al which adds a thermal contribution of ~10% as well as modifying the ρ spectral function to account for interactions with the thermal medium

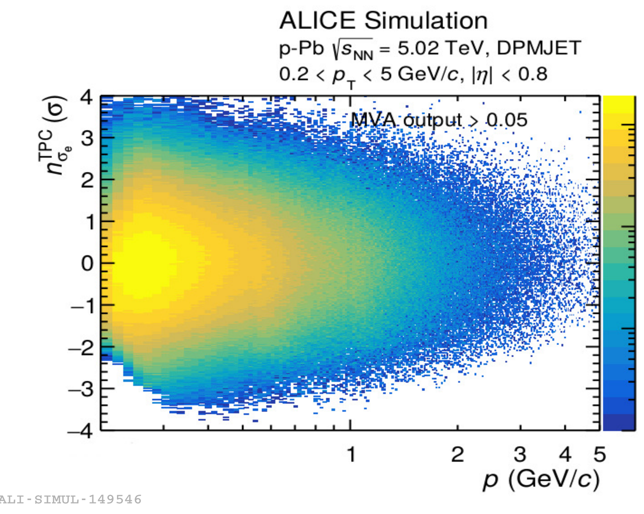


Electron Identification

- Electron identification is crucial to dielectron analyses due to the very low fraction of electrons per event
- The specific energy loss from the Inner Tracking System and the Time Projection Chamber, as well timing from the Time-of-Flight detector, was utilised to perform particle identification.



- This analysis utilised Boosted Decision Trees (TMVA) to select electrons using the above inputs combined with the momentum of each track
- Final selection retained the high purity obtainable with a univariate approach, while significantly increasing the efficiency



Signal Extraction

- To extract the raw dielectron signal the unlike-sign combinatorial background, N_{+-}^{same}, is approximated and removed via the same-event like-sign distribution, B.

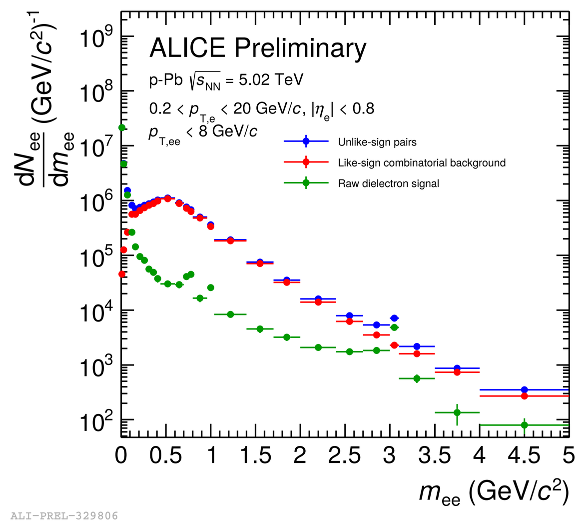
$$B = 2 \cdot \sqrt{N_{++}^{same} \cdot N_{--}^{same}}$$

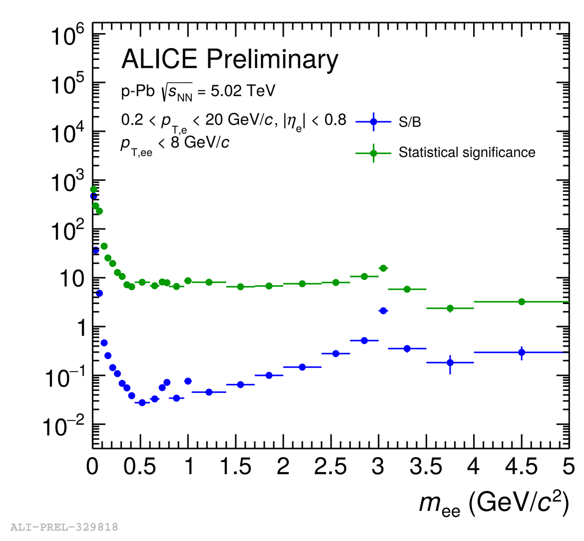
$$signal = N_{+-}^{same} - R \cdot B$$

where R accounts for the different acceptance between the like-sign and unlike-sign dielectron pairs using mixed events

$$R = \frac{N_{+-}^{mixed}}{2 \cdot \sqrt{N_{++}^{mixed} \cdot N_{--}^{mixed}}}$$

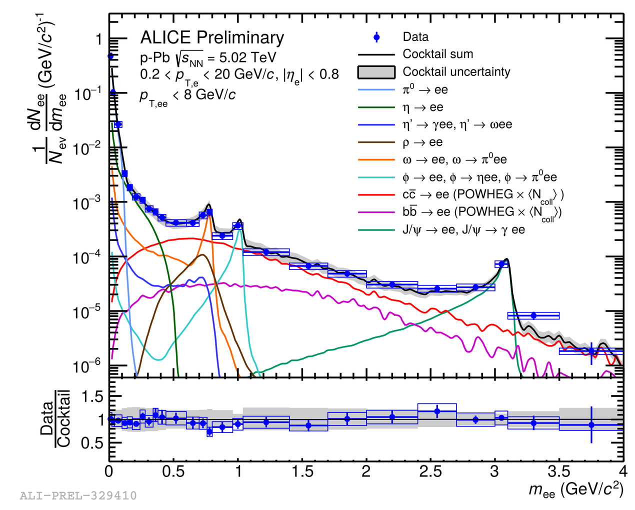
- Strict conversion rejection is applied at the track level to increase the poor S/B

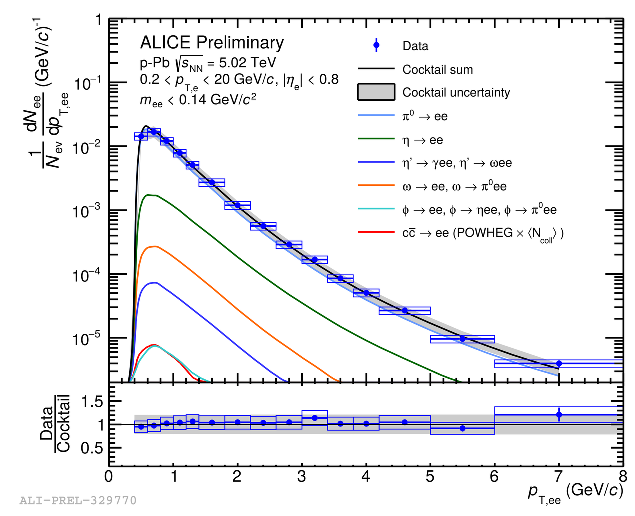




Comparison to Hadronic Cocktail

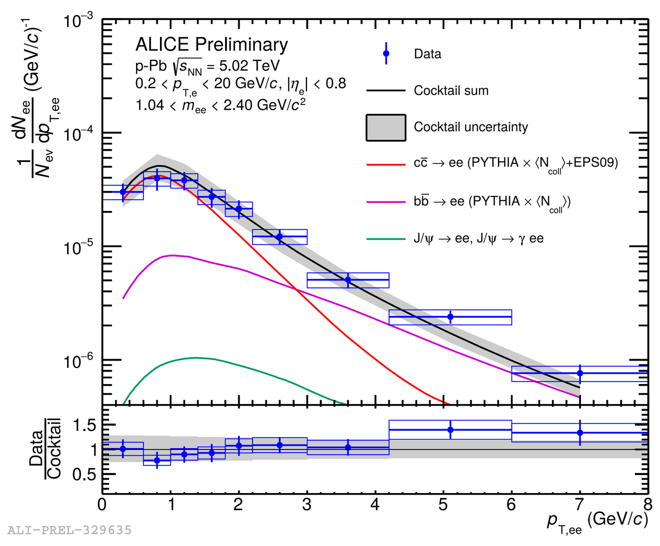
- The dielectron spectrum is compared to a cocktail comprised of known hadronic sources, which is built using as much input from measurement as possible.
- If there is a light flavour component without an available measurement, the π input is used to create that light flavour component.
- It is therefore imperative that the π region shows good agreement (bottom plot)
- The heavy flavour (HF) contributions are built using either PYTHIA or POWHEG and scaled to measured cross sections.

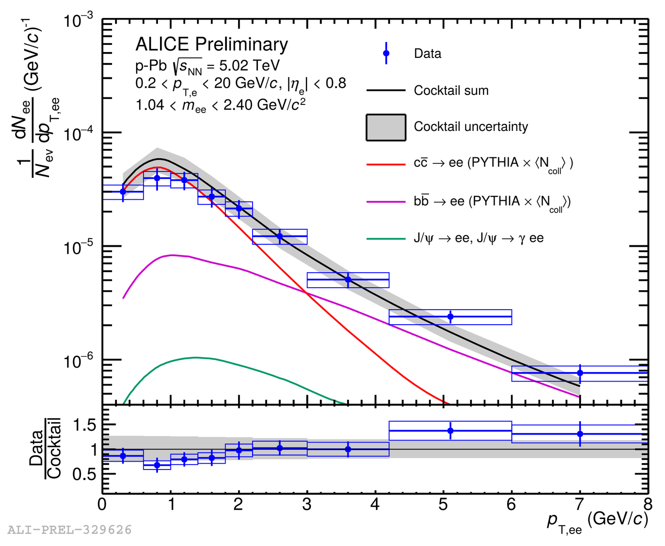


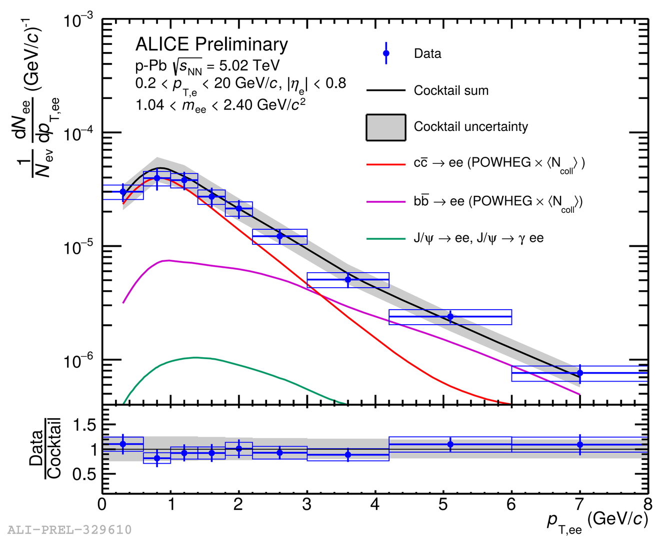


Results

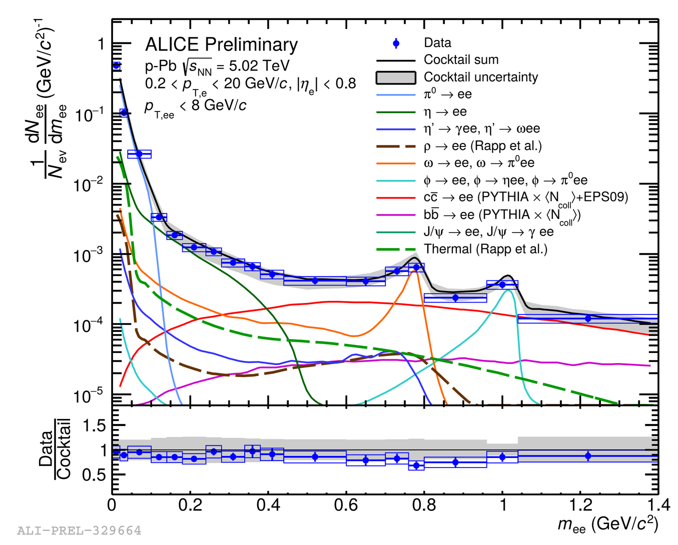
- PYTHIA (bottom left) and POWHEG (bottom right) comparisons in the IMR highlight how sensitive dielectrons are to the HF productions mechanisms
- Such sensitivity currently inhibits conclusions on potential cold nuclear matter effects, for example PYTHIA+EPS09 (top)
- Thus pp measurements are crucial in helping to disentangle these effects -> See poster from L. Viebach

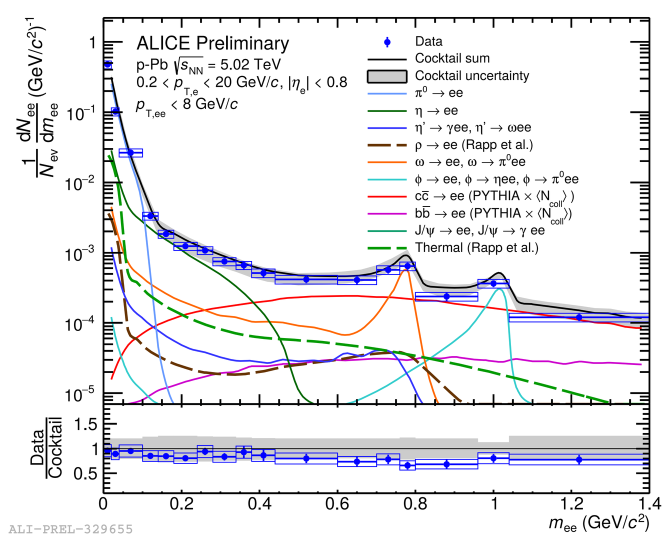


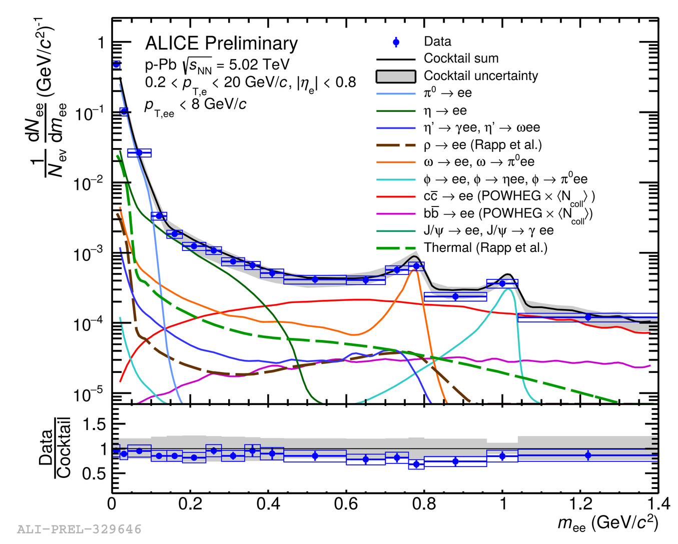




- Thermal contributions (Rapp et. al.) to the dielectron spectrum are available for m_{ee} < ~1.4 GeV
- PYTHIA (bottom left), PYTHIA+EPS09 (top) and POWHEG (bottom right) all show worse agreement with thermal contributions
- Thermal production should scale faster than dielectron production
  -> Multiplicity dependent studies are needed







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