A Large Ion Collider Experiment

ALICE

Topological separation of dielectron signals in Pb–Pb collisions with ALICE

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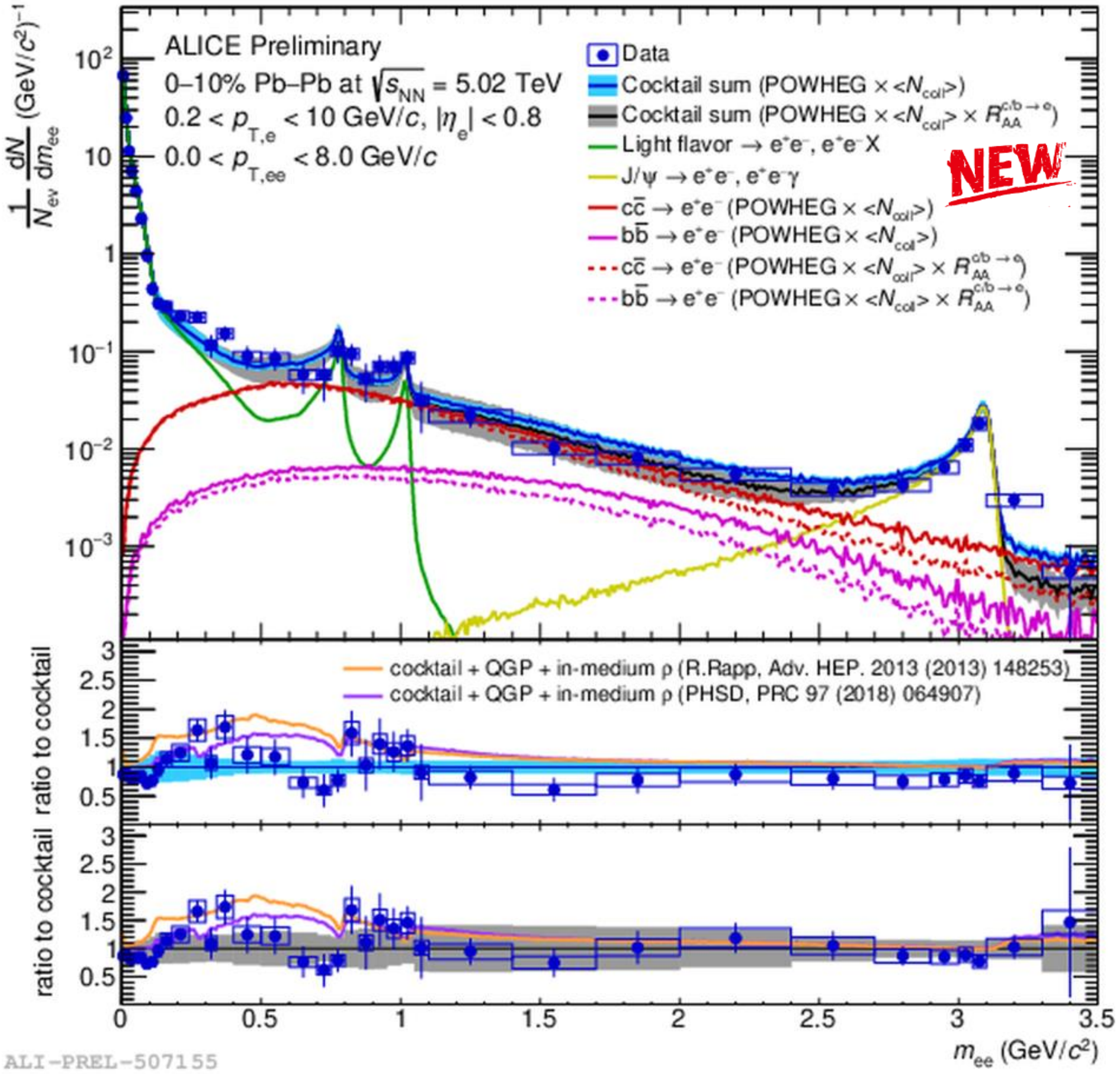
Dielectron production in Pb−Pb at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV

Invariant-mass spectrum



Dielectrons are produced at all stages of the collision and leave the system with negligible final-state interactions

→ Ideal probe to study properties of the quark-gluon plasma (QGP) created in ultra-relativistic heavy-ion collisions

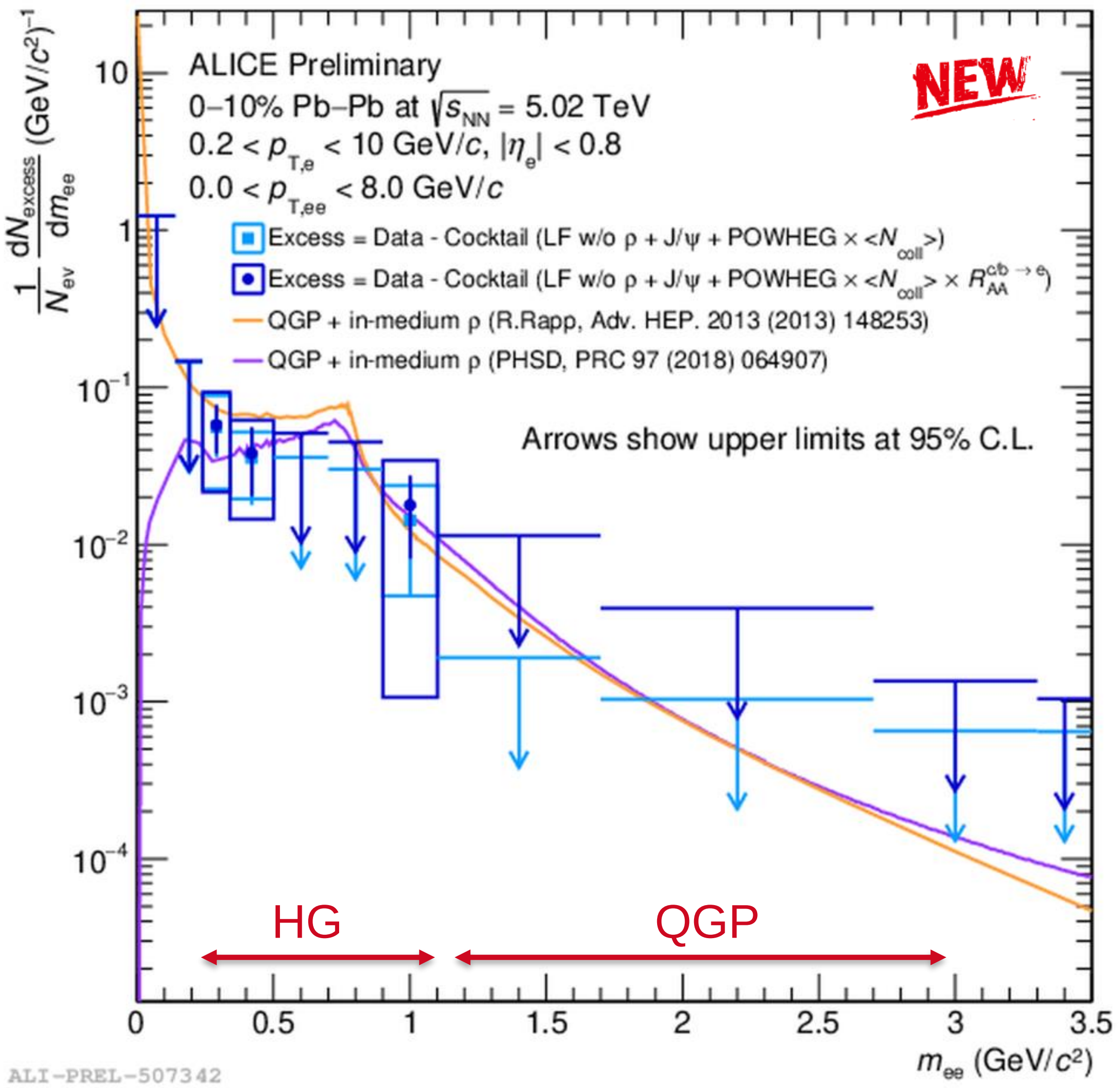
The invariant mass of the pair can be utilised to differentiate between early and late contributions:

At intermediate masses ($1.1 < m_{\mathrm{ee}} < 2.7\ \mathrm{GeV}/c^2$):
- Correlated semi-leptonic decays of heavy-flavor (HF) hadrons
- QGP radiation

At lower masses ($m_{\mathrm{ee}} < 1.1\ \mathrm{GeV}/c^2$):
- Decays of pseudoscalar and vector mesons ($\pi^0, \eta, \eta', \rho, \omega, \phi$)
- Contributions from the hadron-gas (HG) phase

Dielectron production in Pb–Pb at $\sqrt{s_{NN}} = 5.02$ TeV

Excess-yield over hadronic cocktail



Separation of HF and QGP radiation in invariant mass m_{ee} and pair momentum $p_{T,ee}$ challenging

HF production expected to be modified
- Cold-nuclear matter and hot-medium effects
- Indication of HF suppression compared to pp
  → N_{coll}-scaled HF measured in pp exceeds the data
    Phys. Rev. C 102 (2020) 055204

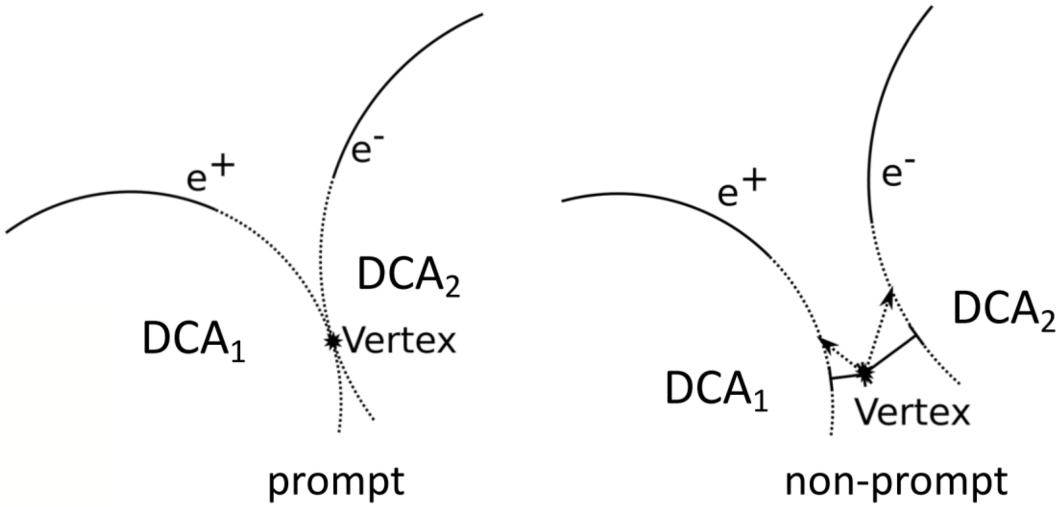
HF modification can be modelled using the measured R_{AA} of $c/b \rightarrow e^{\pm}$
    Phys. Lett. B 804 (2020) 135377

However: Large uncertainties of the measurements only allow upper limits for thermal contribution of the QGP

→ Cocktail independent method needed to access QGP radiation in the intermediate-mass region (IMR)

$\mathrm{DCA_{ee}}$ analysis

Distance-of-closest approach (DCA):



Separation of prompt and non-prompt sources based on their decay topology:

→ Decay length of D- and B-mesons much larger than that of prompt sources

→ $\mathrm{DCA_{ee}(thermal)} < \mathrm{DCA_{ee}(HF)}$

prompt non-prompt

Gives access to measurements of:

→ Thermal radiation at low $\mathrm{DCA_{ee}}$

→ Suppression of HF production at high $\mathrm{DCA_{ee}}$

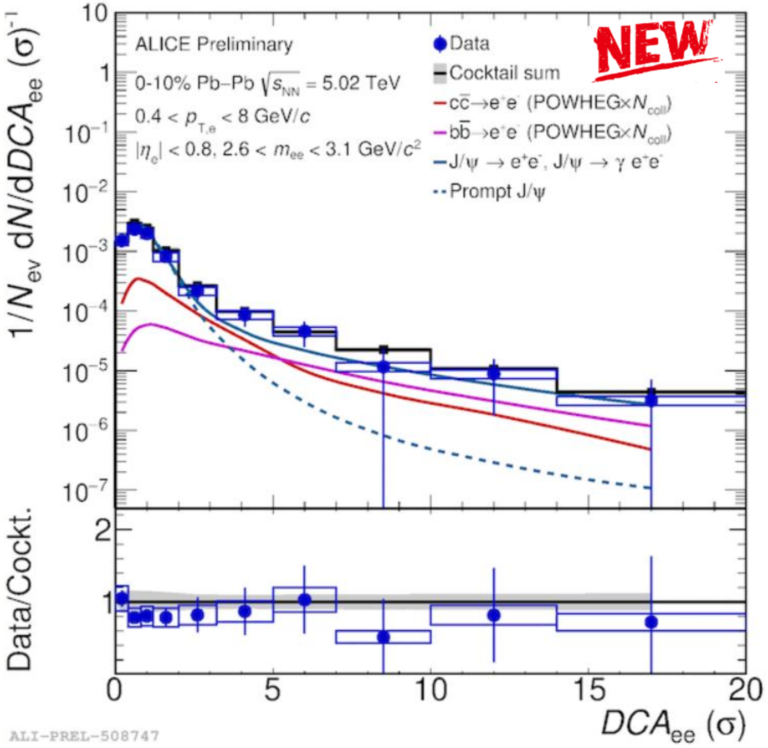
DCA for pairs taking into account the DCA resolution:

$$\mathrm{DCA_{ee}} = \sqrt{\frac{(\mathrm{DCA_1}/\sigma_1)^2 + (\mathrm{DCA_2}/\sigma_2)^2}{2}}$$

Already applied in pp collisions at $\sqrt{s} = 7$ TeV: JHEP 09 (2018) 064

Cocktail-scaled $\mathrm{DCA_{ee}}$ templates

J/ψ-mass region

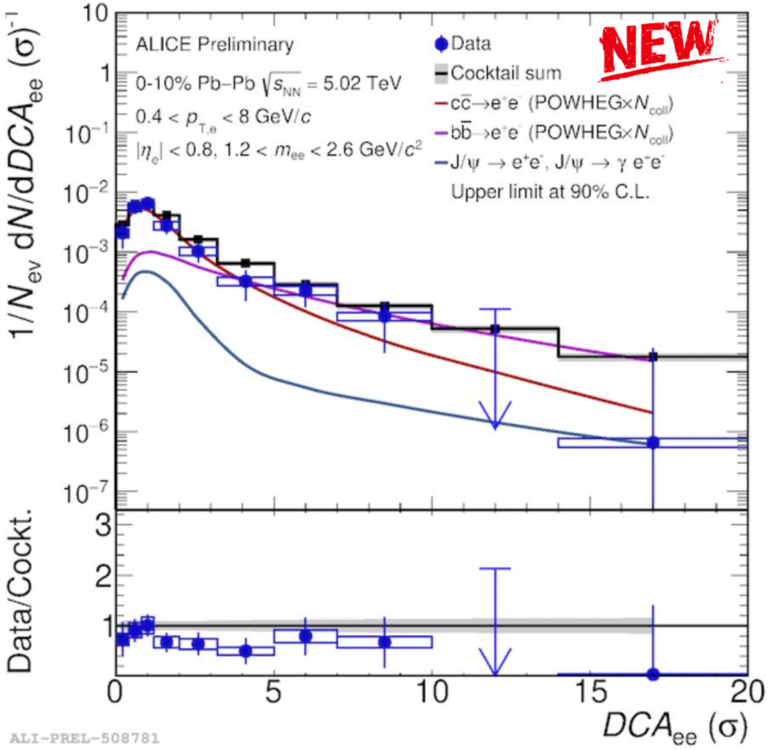


Well suited as a control region:

- Mixture of prompt & non-prompt sources
- J/ψ production well constrained by measurements

→ Data well described by $\mathrm{DCA_{ee}}$ templates scaled with the hadronic cocktail

Intermediate-mass region



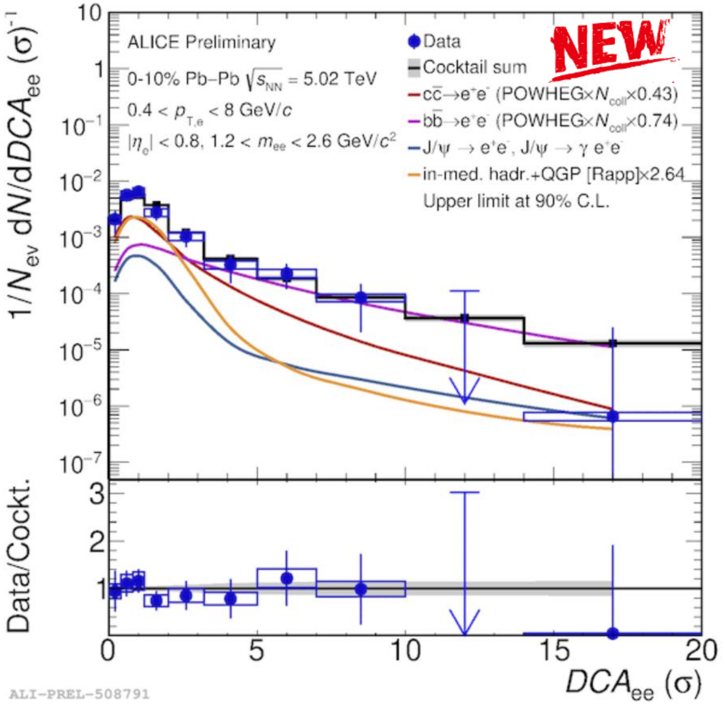
Comparison to HF-N_{coll} scaled cocktail:

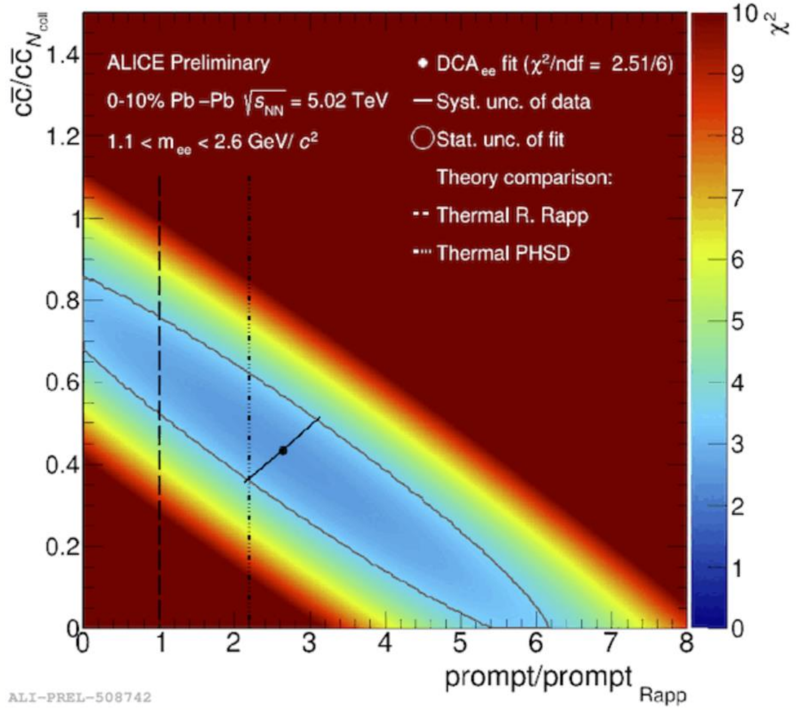
- Beauty dominates the spectrum at high $\mathrm{DCA_{ee}}$
- Charm more prominent at low $\mathrm{DCA_{ee}}$

→ Data below HF expectation

→ Clear indication of HF suppression

$\mathrm{DCA_{ee}}$ template fits to data





Adv. High Energy Phys. 2013 (2013) 148253
Phys. Rev. C 97 (2018) 064907

Extraction of prompt thermal signal via template fits:

- Beauty contribution fixed via separate fit at high $\mathrm{DCA_{ee}}$
  $\mathrm{b\bar{b}}$: 0.74±0.24(stat.)±0.12(syst.) (w.r.t. N_{coll} scaling)
- Simultaneous fit of charm and prompt contribution
  $\mathrm{c\bar{c}}$: 0.43±0.40(stat.)±0.22(syst.) (w.r.t. N_{coll} scaling)
  prompt: 2.64±3.18(stat.)±0.29(syst.) (w.r.t. R. Rapp)

First $\mathrm{DCA_{ee}}$ analysis in central Pb−Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV to separate thermal radiation & HF background
Method independent of hadronic cocktail but currently limited by statistics
→ Run 3 and beyond with better $\mathrm{DCA_{ee}}$ resolution (x3-6) and much more statistics (x100)