Low-mass dielectron production in pp and Pb–Pb collisions in ALICE

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Hot Quarks, Copamarina, Puerto Rico
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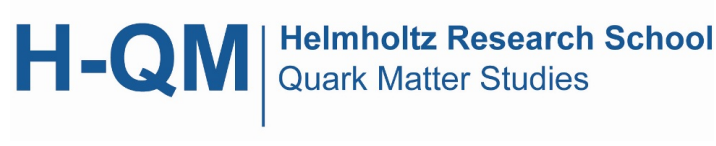
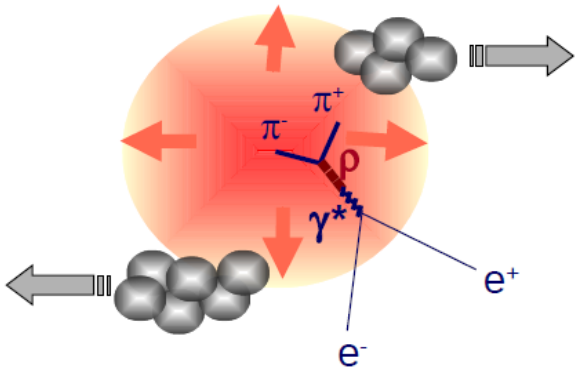


Dielectrons



advantage

- mean free path $\lambda \propto 1/\alpha^2$
  $\rightarrow \lambda_{em}/\lambda_{strong} \sim 10^4$
- negligible final state interaction

but ...

- low branching ratios, e.g.

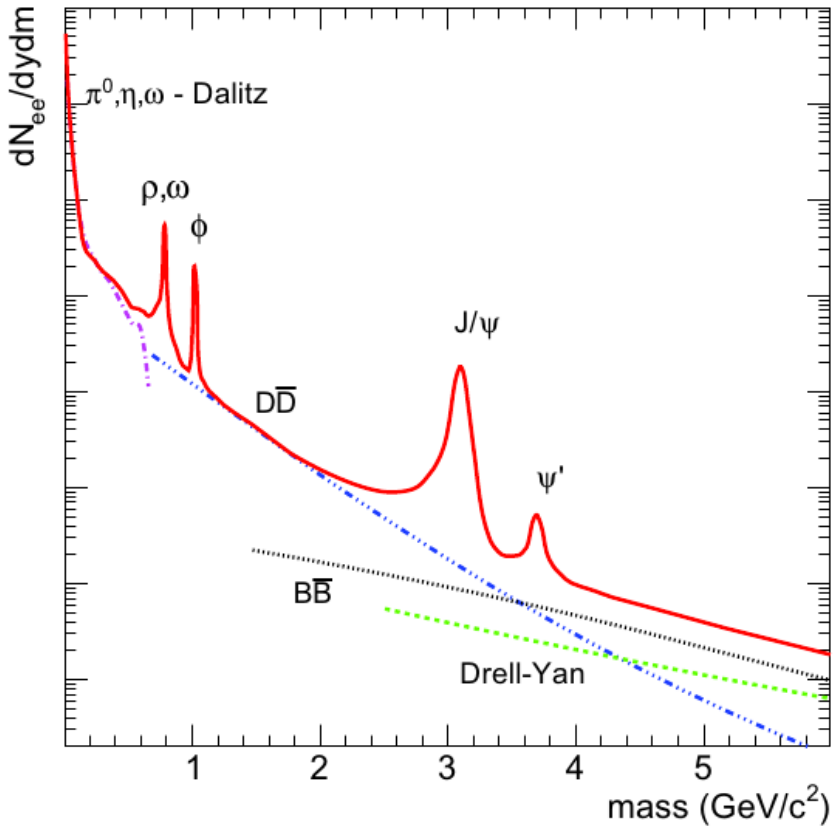
$$\phi \rightarrow K^+K^- (\text{BR:}0.5)$$
$$\phi \rightarrow ee\ (\text{BR:}3 \times 10^{-4})$$

Expected hadronic dielectron sources

low masses $\rightarrow$ low-mass vector mesons/Dalitz decays

intermediate masses $\rightarrow$ semi-leptonic heavy flavour decays

high masses $\rightarrow$ heavy quarkonia/hard processes



A. Drees, Nucl. Phys. A830 (2009), 435

Physics motivation for low-mass dielectron measurement

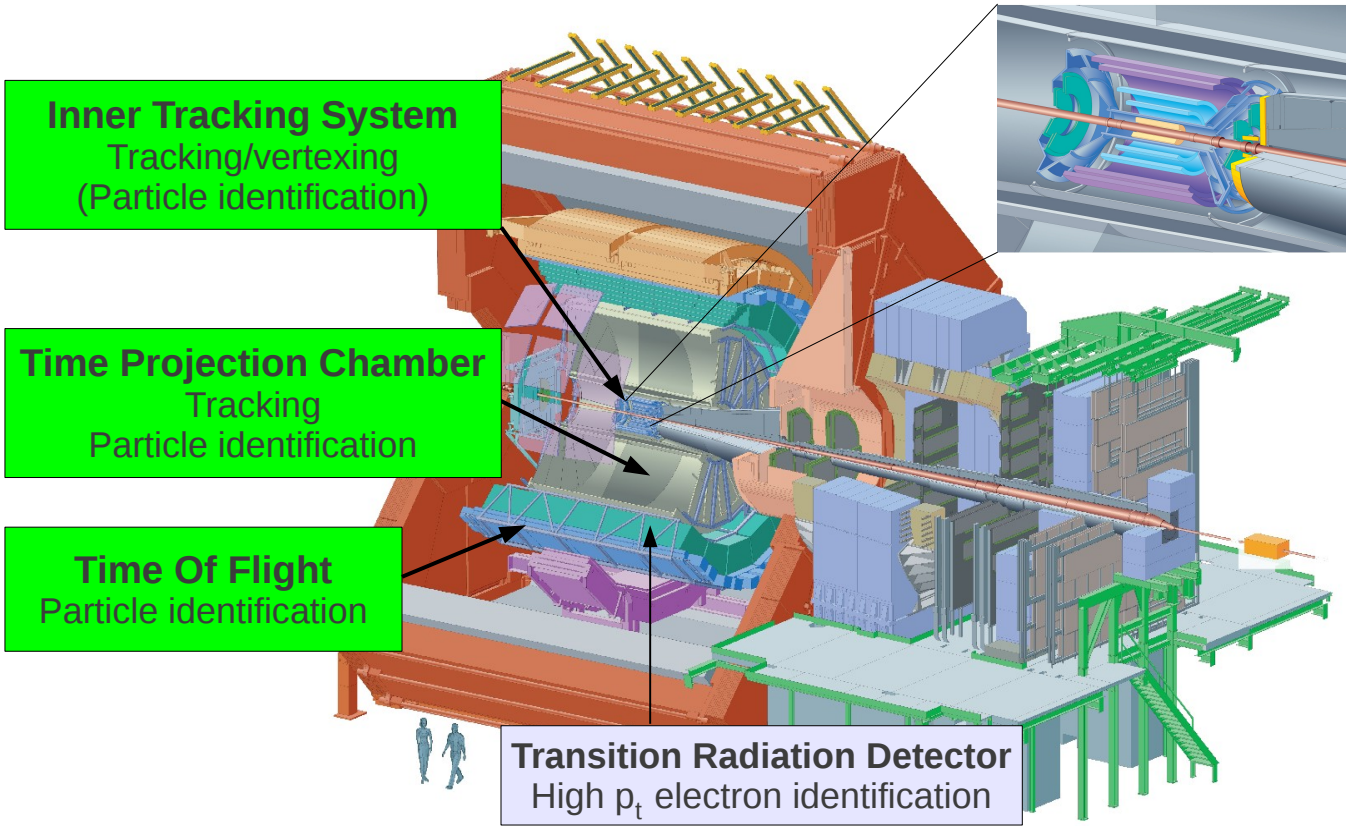
proton-proton collision

- transverse momentum spectra of light vector mesons
- heavy flavour production mechanisms
- direct photons (test of pQCD)
- baseline measurement for heavy-ion collisions

Pb–Pb collision

- investigation of medium modifications/properties

A Large Ion Collider Experiment



Data sample

- 2010 pp
- 3.5×10^8 MB events
- 2011 Pb–Pb
- 16×10^6 central events (0-10%)

coverage of central barrel $0 < \varphi < 2\pi \qquad |\eta| < 0.9$

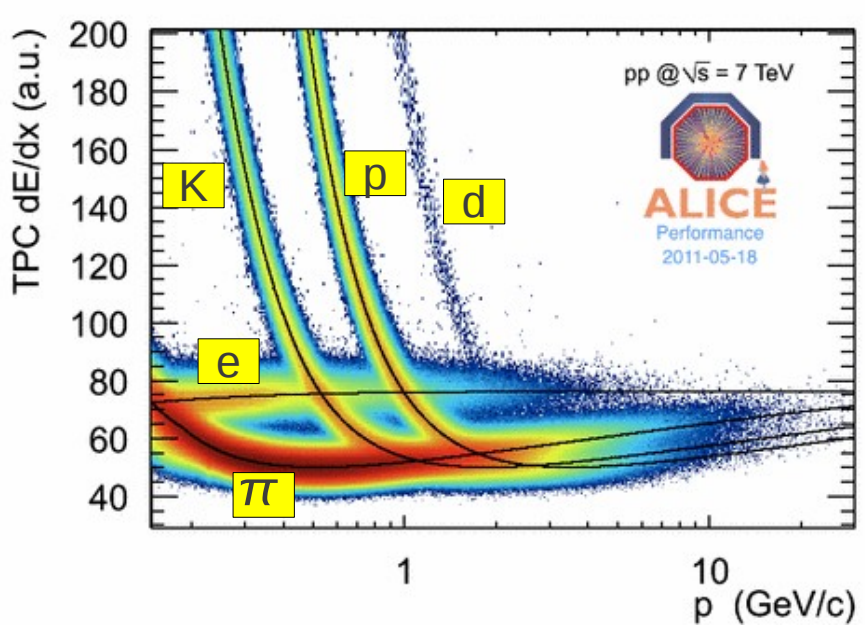
mass resolution $\Delta m/m \sim 1\%$

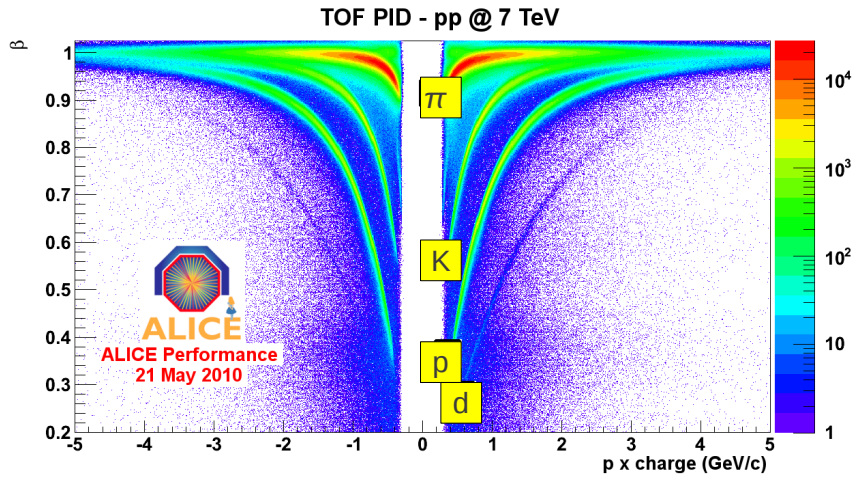
Track selection

$\rightarrow$ challenge of electron identification

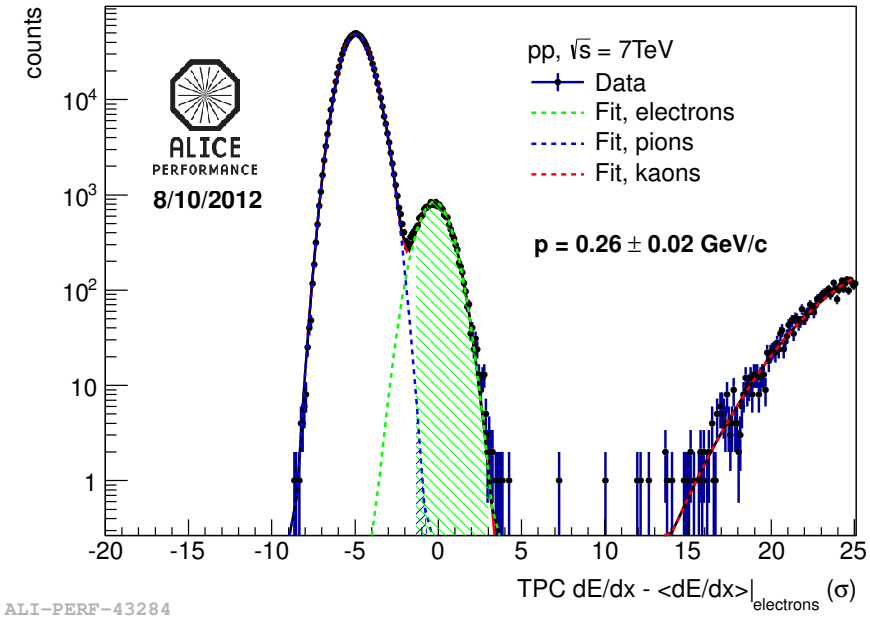
involved detectors

- Time Projection Chamber (pion rejection)
- Time-Of-Flight (kaon and proton rejection)





Electron Purity



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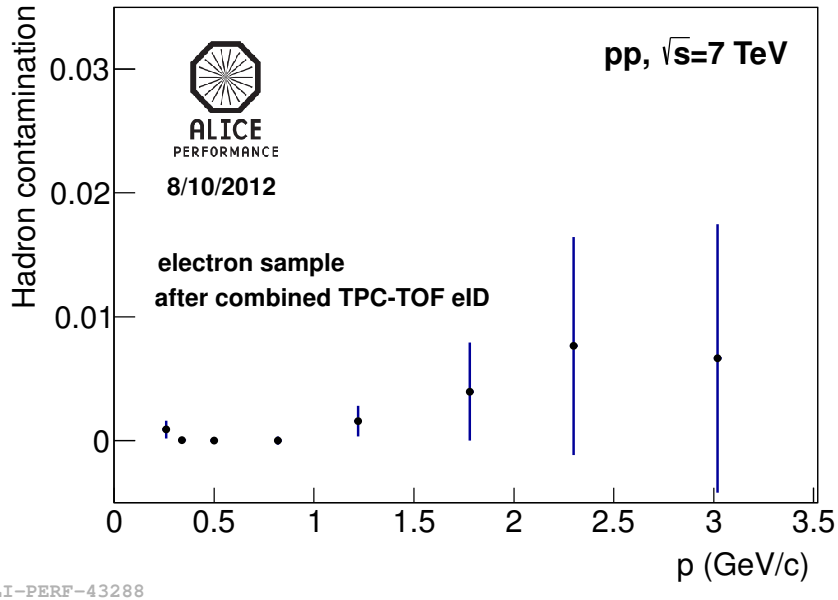

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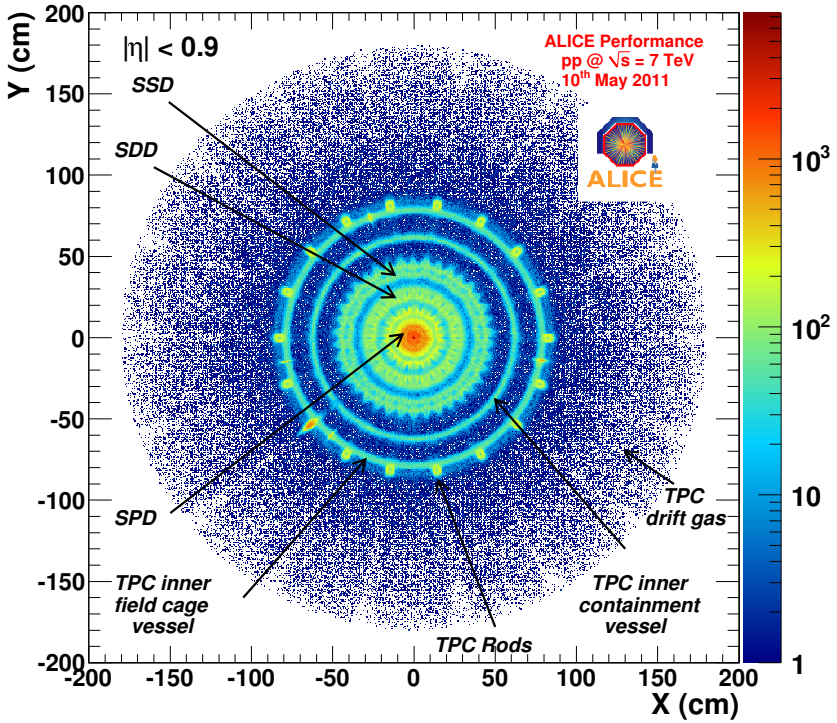
- in total $\sim$ 1% misidentified electrons
- negligible amount to be subtracted by combinatorial background

Photon conversions

Two independent ways to identify photon candidates

1. displaced vertex
2. dielectron pair plane orientation with respect to magnetic field



- contamination of photon conversions a few percent in the low-mass region ($m_{ee} \lesssim 0.1$ GeV/c^2)

Dielectron pair analysis

- consideration of all pair combinations of e^+e^-

  $\rightarrow$ combinatorial background

$$\underbrace{N_{+-}}_{\text{measured}} = S_{+-} + N_{+-}^{\text{CombBkg}}$$

- Available methods

  $\rightarrow$ track rotation

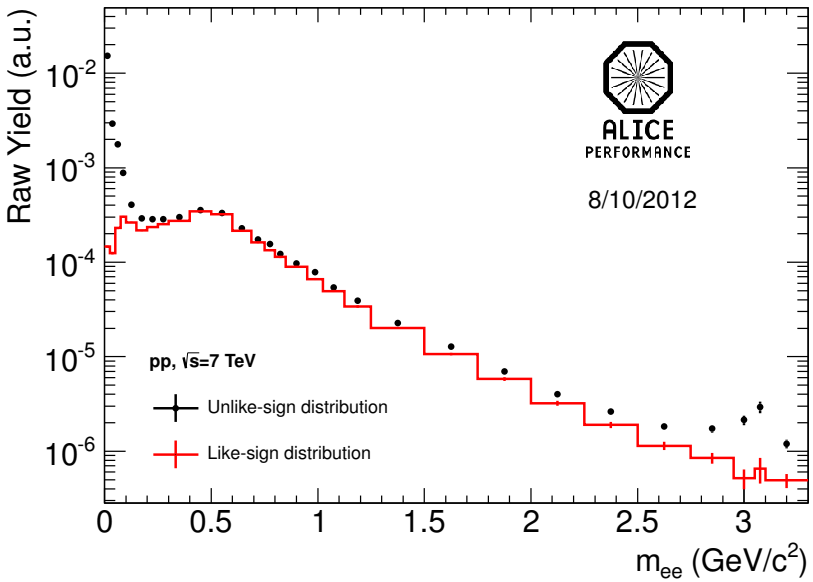
  $\rightarrow$ mixed event technique

  $\rightarrow$ same-event like-sign method

$$N_{+-}^{\text{CombBkg}} = \underbrace{2 \times \sqrt{N_{++}N_{--}}}_{\text{Like-sign}} * \overbrace{R_{Acc}}^{\text{from mixed events}}$$

- So far, the focus is on the like-sign distribution

Invariant mass spectra



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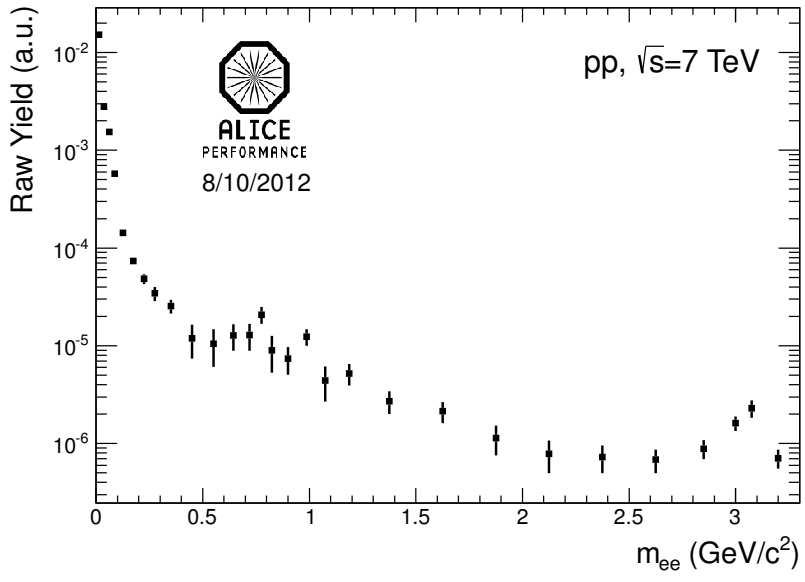

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- most unlike-sign pairs orginate from uncorrelated electrons
- raw signal is extracted by the subtraction of the combinatorial background
- different sources contribute to different mass ranges

Hadronic cocktail simulation

- transverse momentum distributions of π^0 as baseline
- other particle contributions are scaled correspondingly by model or measurements (η, ϕ and J/ψ)
- so far, the $D\bar{D}$ contribution based on PYTHIA kinematics (with measured cross section by ALICE)

Measured input spectra

- π^0, η: Phys.Lett.B717:162-172,2012
- ϕ: arXiv:1208.5717
- $\sigma_{\bar{c}c}$: arXiv:1205.4007
- J/ψ: Phys.Lett.B704:442-455,2011

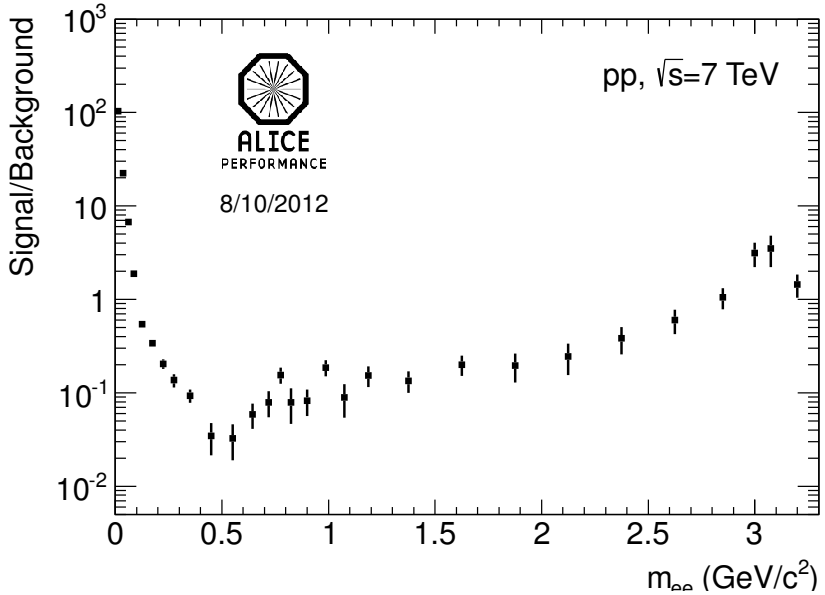
Efficiency correction

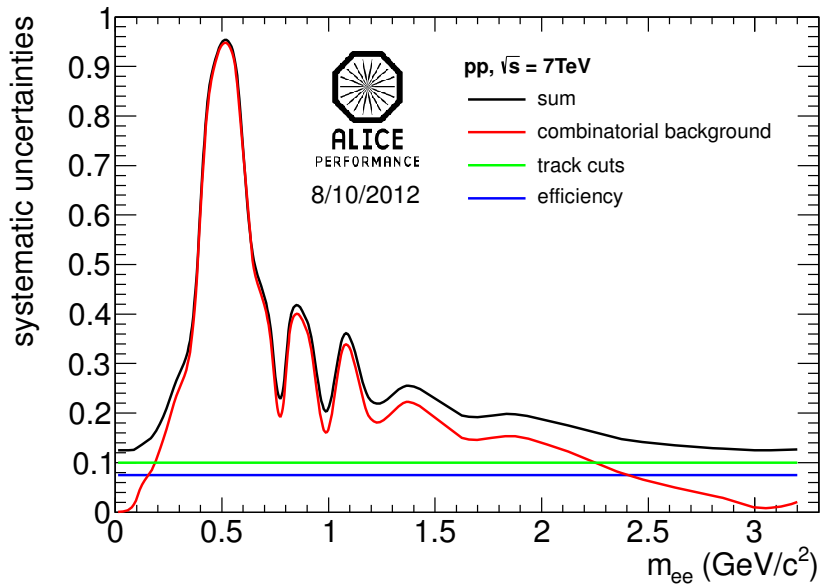
- efficiency correction of detector effects
- Monte Carlo simulations are used for corrections
- the efficiency is extracted on track level (p_T, η, φ)
- correction factor on pair level is about 10-15%

Systematic uncertainty

Different sources

- dominating source is the combinatorial background $\rightarrow \frac{\mathrm{d}S}{S} = \frac{\mathrm{d}B}{B} \times \left(\frac{S}{B}\right)^{-1}$
- track cuts
- efficiency
- normalization





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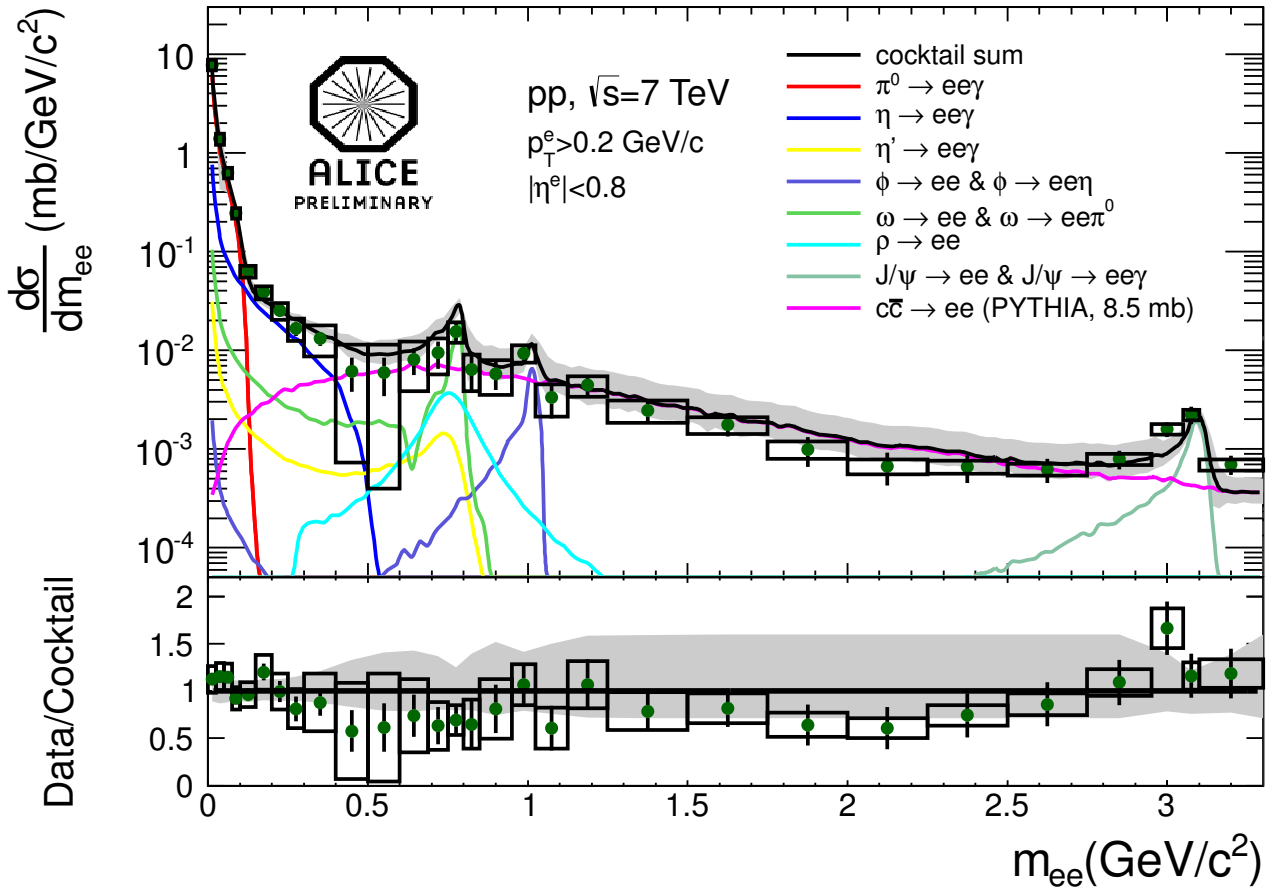
Comparison to hadronic sources



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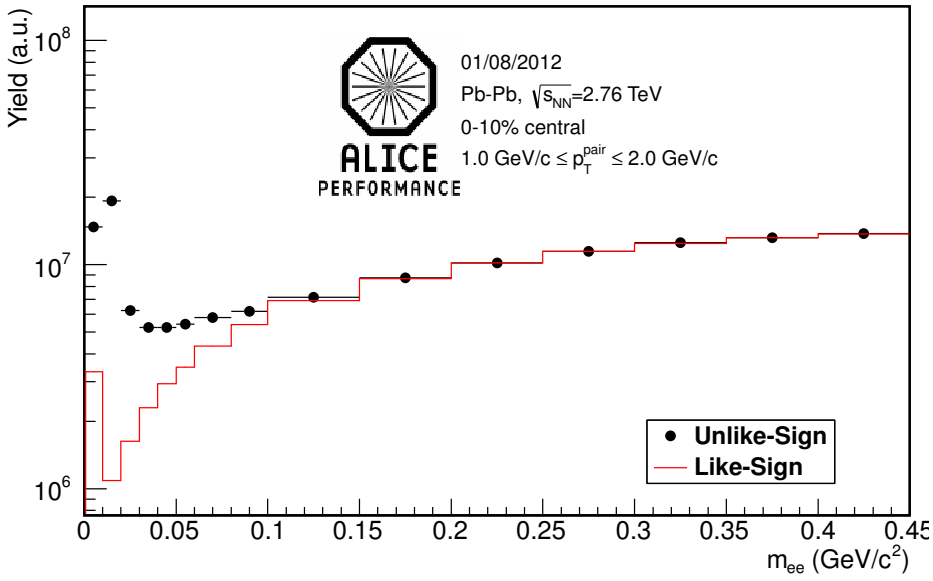
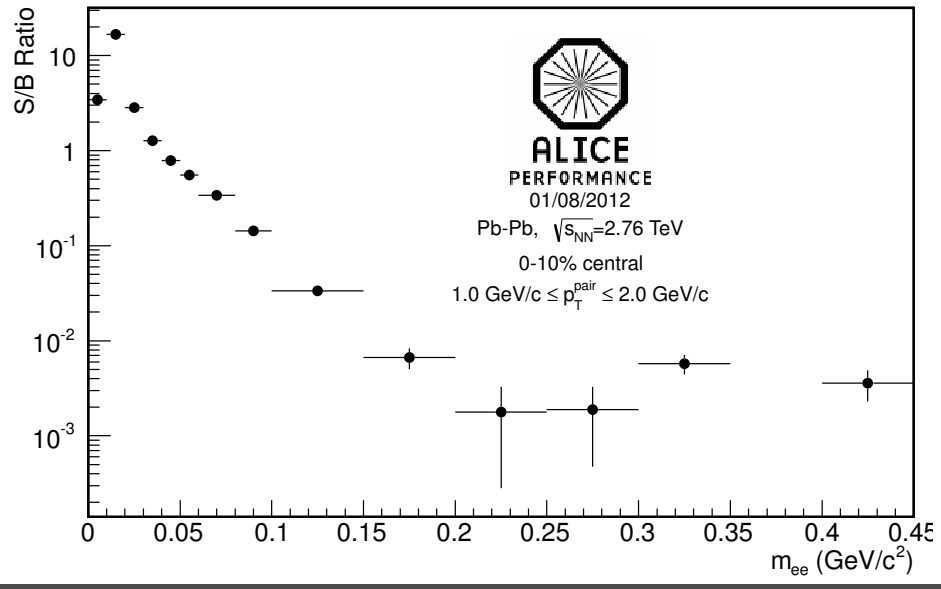
- cocktail and data are in agreement

Outlook for Pb–Pb





- Very small S/B ratio (here $p_T^e > 0.4$ GeV/c)
- detailed study of background systematics ongoing

Summary and Outlook

Summary

- First dielectron continuum measurement in ALICE presented for pp collisions at $\sqrt{s} = 7$ TeV
- Invariant mass measurement agrees to hadronic cocktail calculations in the range $0 < m_{ee} < 3.3$ GeV$/c^2$
- Analysis in Pb–Pb needs very good knowledge of combinatorial background

Outlook

- physics to be investigated from dielectron measurements in pp and Pb–Pb collisions

  $\rightarrow$ virtual photons, in-medium modifications ...
- outstanding possibilities for low-p_{t} physics with ALICE at LHC

BackUp