# Measurement of low-mass dielectrons in inelastic and high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV with ALICE

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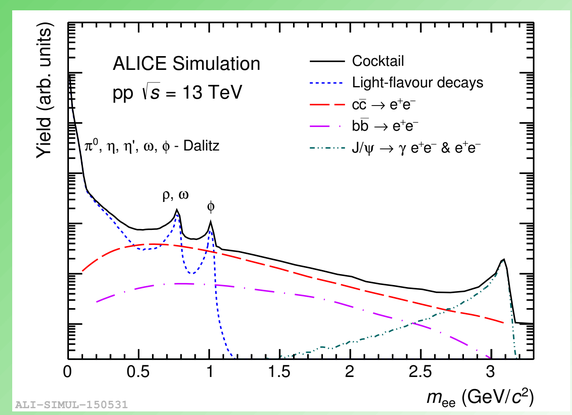
## Motivation

Low-mass dielectrons − penetrating probe to study the system created in high-energy heavy-ion collisions
- Produced during all stages of collision
- Unaffected by strong interactions

Why proton–proton collisions?
- Medium-free reference
- Heavy-flavour production cross sections

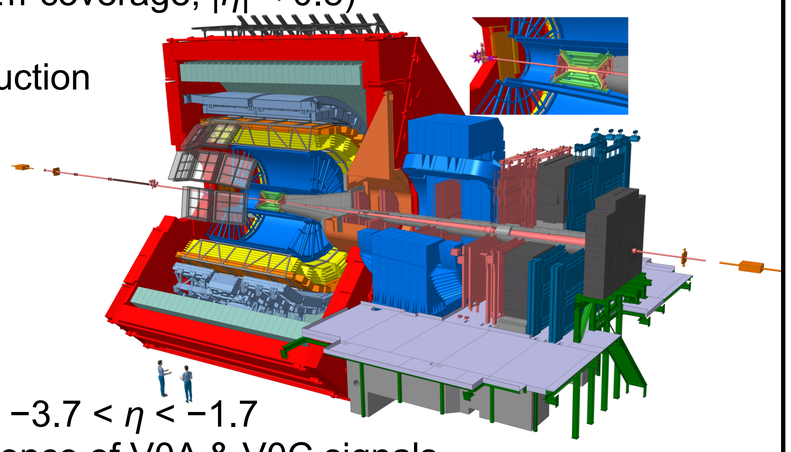



*New (or heavy-ion like) phenomena in **high-multiplicity** pp events?* [1]
- Production / destruction of ρ meson
- Thermal radiation in small system
- Understanding of Multiple Parton Interactions
- *Idea*: produce a ratio of dielectron spectra in high-multiplicity (HM) over inelastic (INEL) events

$$\frac{N_{ee}(\mathrm{HM})}{\langle N_{ee}(\mathrm{INEL})\rangle} \times \frac{\langle \mathrm{d}N_{ch}/\mathrm{d}\eta(\mathrm{INEL})\rangle}{\mathrm{d}N_{ch}/\mathrm{d}\eta(\mathrm{HM})}$$

## Experimental Setup

Central barrel detectors (2π coverage, $|\eta| < 0.8$)



**I**nner **T**racking **S**ystem
- Collision vertex reconstruction
- Tracking

**T**ime **P**rojection **C**hamber
- Tracking
- Particle Identification

**T**ime **O**f **F**light
- Particle Identification

**V0** scintillators
- V0A: $2.8 < \eta < 5.1$, V0C: $-3.7 < \eta < -1.7$
- Min.-bias trigger: coincidence of V0A & V0C signals
- HM trigger: coincidence of V0A & V0C signals, threshold on V0M amplitude (0.036% of INEL events)

$\mathcal{L}_{int}^{MB}$ = 7.87 ± 0.40 nb$^{-1}$, $\mathcal{L}_{int}^{HM}$ = 2.79 ± 0.15 pb$^{-1}$

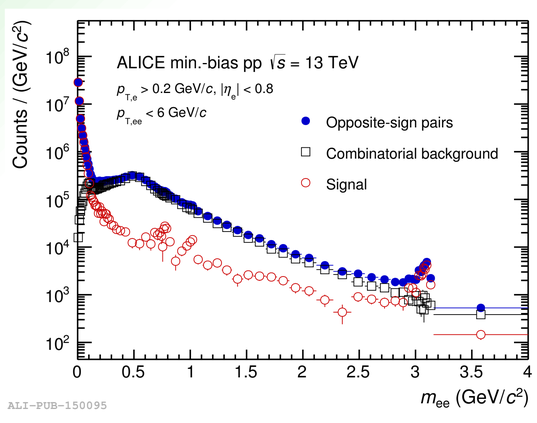
**$\mathrm{d}N_{ch}/\mathrm{d}\eta$(HM) / $\langle \mathrm{d}N_{ch}/\mathrm{d}\eta$(INEL)$\rangle$ = 6.27 ± 0.22** (measured at $\eta \sim 0$)

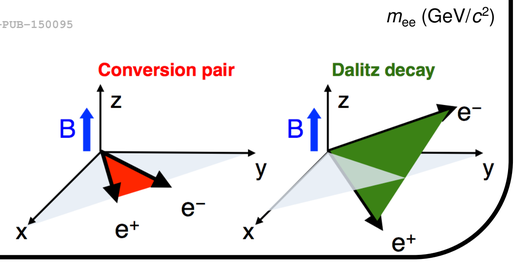
## Pair Analysis

- Signal calculation: $S = N_{+-} - B$
- Combinatorial background from geometric mean of like-sign pairs from same event: $B = R \cdot 2\sqrt{N_{++} \cdot N_{--}}$
- Relative acceptance correction factor from mixed events:

$$R = \frac{N_{+-,\mathrm{MIX}}}{2\sqrt{N_{++,\mathrm{MIX}} \cdot N_{--,\mathrm{MIX}}}}$$

Rejection of photon conversions:
- Pair orientation relative to the magnetic field
- No ITS clusters shared with other tracks




## Cocktail of hadronic sources

- Light-flavour (LF) cocktail calculations based on ALICE measurements [2 - 6]
  - h± at 13 TeV, h±/π± at 7 TeV → π± at 13 TeV
  - PYTHIA 8 (Monash 2013) for ρ/π and ω/π ratios (good description of data [5,6])
  - $m_T$ scaling for other hadrons (η' and ϕ)
- Heavy-flavour (HF) contribution from PYTHIA 6 (Perugia 2011) simulation of open charm and beauty production

Input for high-multiplicity cocktail calculations:



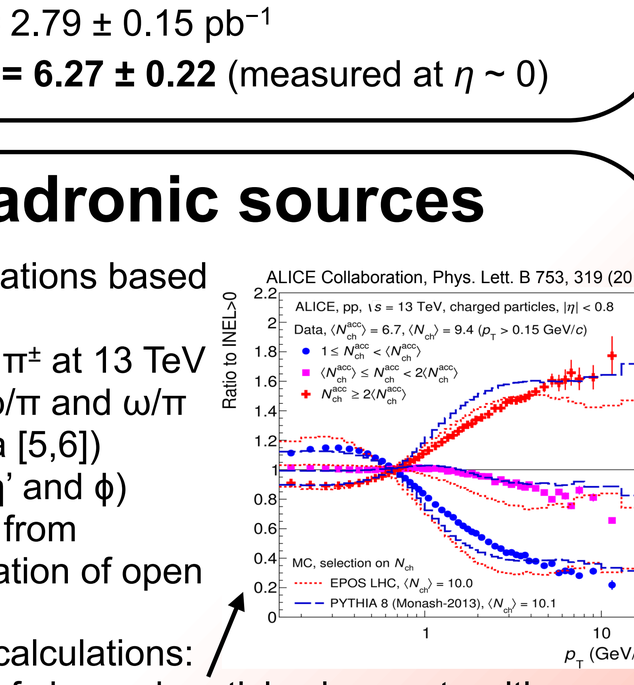

- LF: modification of $p_T$ spectrum of charged particles in events with higher multiplicities [7]
- HF: multiplicity dependent production of D meson [8] and inclusive J/ψ [9] in pp at $\sqrt{s}$ = 7 TeV
- Same enhancement for beauty is assumed as for open charm [8, 10]

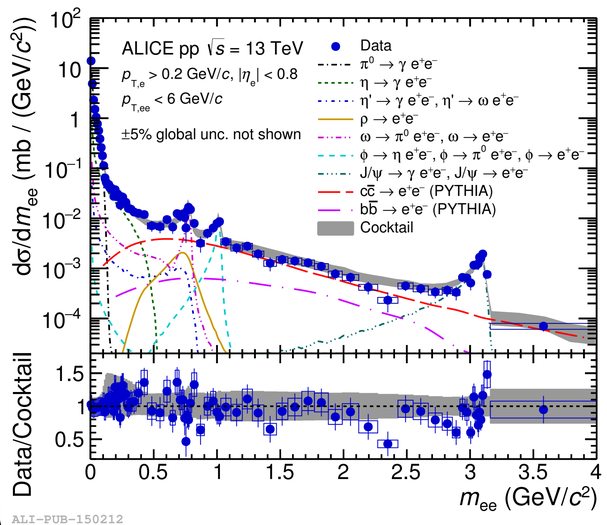
## Results

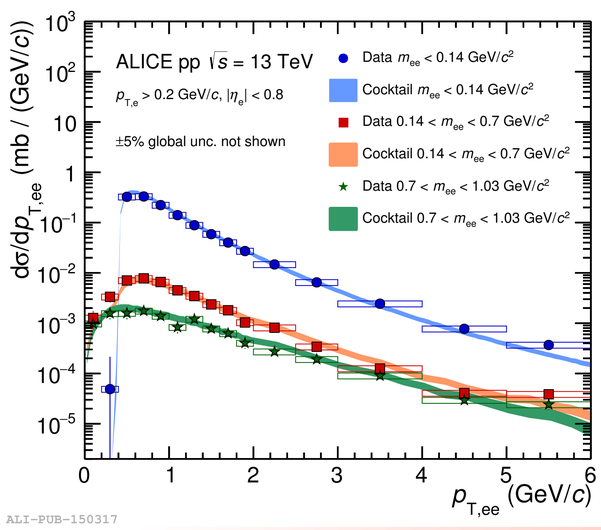
Good description of dielectron production in inelastic pp collisions with cocktail expectations

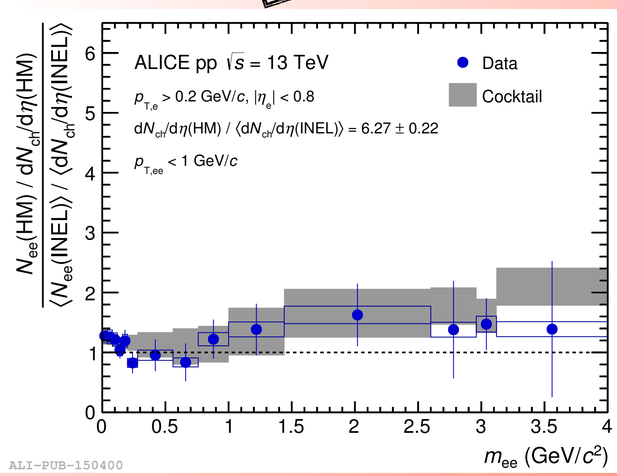
Ratio of dielectron spectra in HM over INEL events scaled with $\mathrm{d}N_{ch}/\mathrm{d}\eta$(HM) / $\langle \mathrm{d}N_{ch}/\mathrm{d}\eta$(INEL)$\rangle$ = 6.27 ± 0.22
- Good agreement with cocktail expectations over whole measured $m_{ee}$ and $p_{T,ee}$ range—see no modifications beyond established ones [6 - 8]
- Light-flavour sources (in particular $\pi^0$ and η): same multiplicity dependence as a function of $m_T$
- Agreement at high $p_{T,ee}$ confirms assumption that beauty scales with multiplicity similarly to open charm

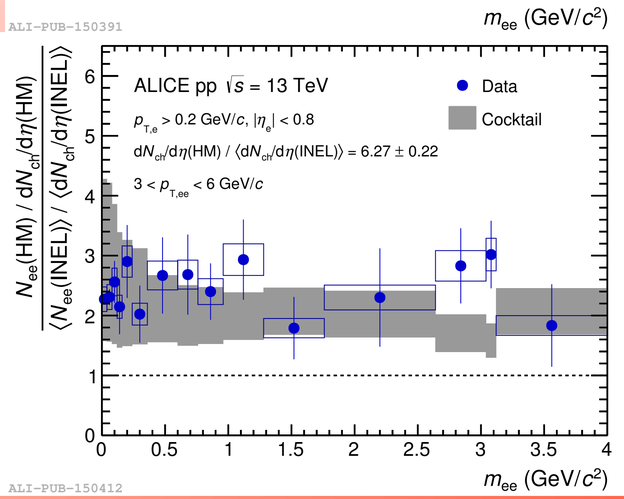
**arXiv:1805.04407**
**Submitted to PLB**




***Further results: heavy-flavour production cross sections [A. Dashi, poster ID 879] and direct photons [O. Vazquez, poster ID 880]***

## References


[1] C. Loizides, Experimental overview on small collision systems at the LHC, Nucl.Phys. A956 (2016) 200
[2] ALICE Collaboration, "Pseudorapidity and transverse-momentum distributions of charged particles in proton-proton collisions at $\sqrt{s}$ = 13 TeV", PLB 753 (2016) 319
[3] ALICE Collaboration, "Energy dependence of the transverse momentum distributions of charged particles in pp collisions measured by ALICE", EPJ C (2013) 73: 2662
[4] ALICE Collaboration, "Neutral pion and η meson production in pp collisions at $\sqrt{s}$ = 0.9 TeV and $\sqrt{s}$ = 7 TeV," PLB 717 (2012) 162
[5] ALICE Collaboration, "Production of the ρ(770)$^0$ meson in pp and Pb–Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV", arXiv:1805.04365
[6] ALICE Collaboration, "Production of ω(782) in pp collisions at $\sqrt{s}$ = 7 TeV", ALICE-PUBLIC-2018-004. https://cds.cern.ch/record/2316785.
[7] ALICE Collaboration, "Pseudorapidity and transverse-momentum distributions of charged particles in proton-proton collisions at $\sqrt{s}$ = 13 TeV", PLB 753, 319 (2016)
[8] ALICE Collaboration, "Measurement of charm and beauty production at central rapidity versus charged-particle multiplicity in proton-proton collisions at $\sqrt{s}$ = 7 TeV", JHEP 09, 148 (2015)
[9] ALICE Collaboration, "J/ψ production as a function of charged particle multiplicity in pp collisions at $\sqrt{s}$ = 7 TeV," PLB 712 (2012) 165
[10] F. Fionda, poster at this conference (poster ID 291)



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