Dielectron physics opportunities with ALICE 3

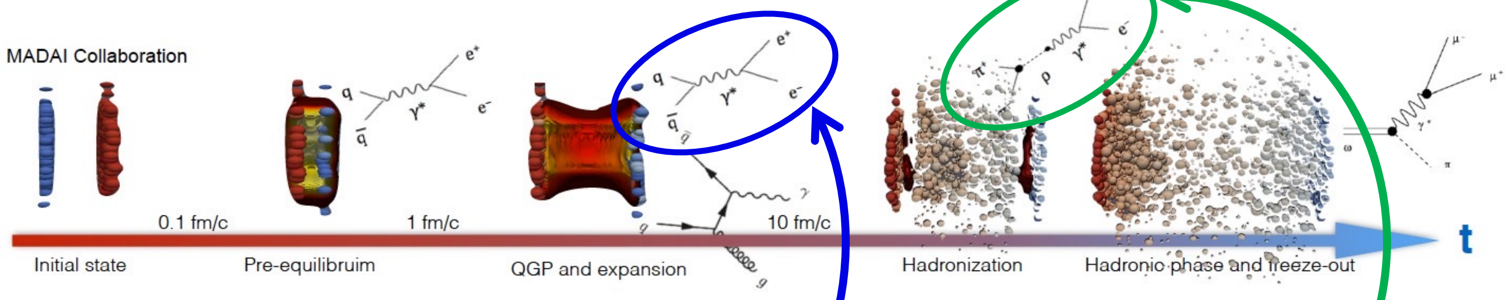
Florian Eisenhut

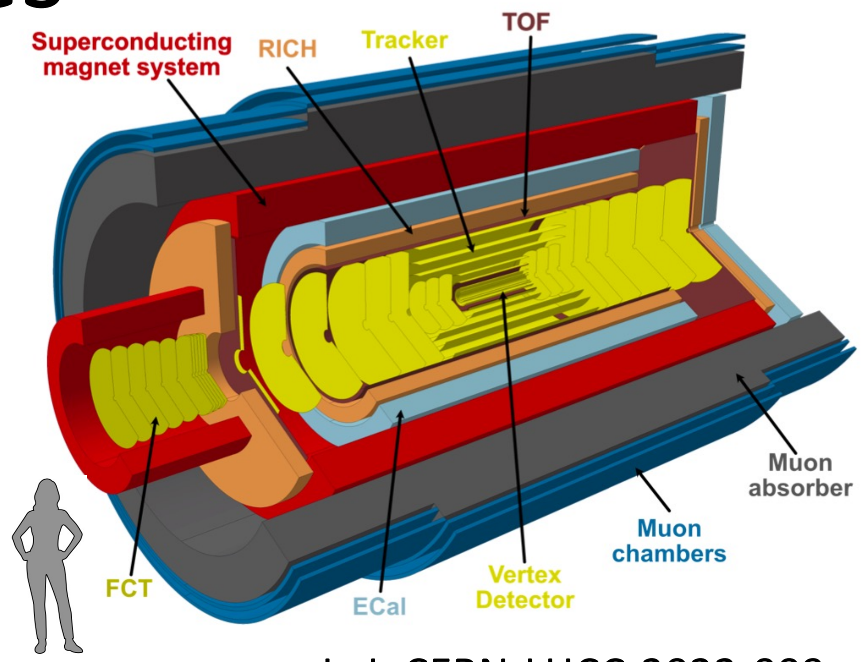
for the ALICE collaboration

Quarkmatter 2022 – Kraków

Contact:
Florian Eisenhut
florian.eisenhut@cern.ch
Goethe-University Frankfurt am Main

ALICE 3
Dielectron opportunities





Dielectron studies in Run 5 (ALICE 3) are intended to address :

- Thermal radiation
- Chiral-symmetry restoration

LoI: CERN-LHCC-2022-009

ALICE 3 characteristics in short

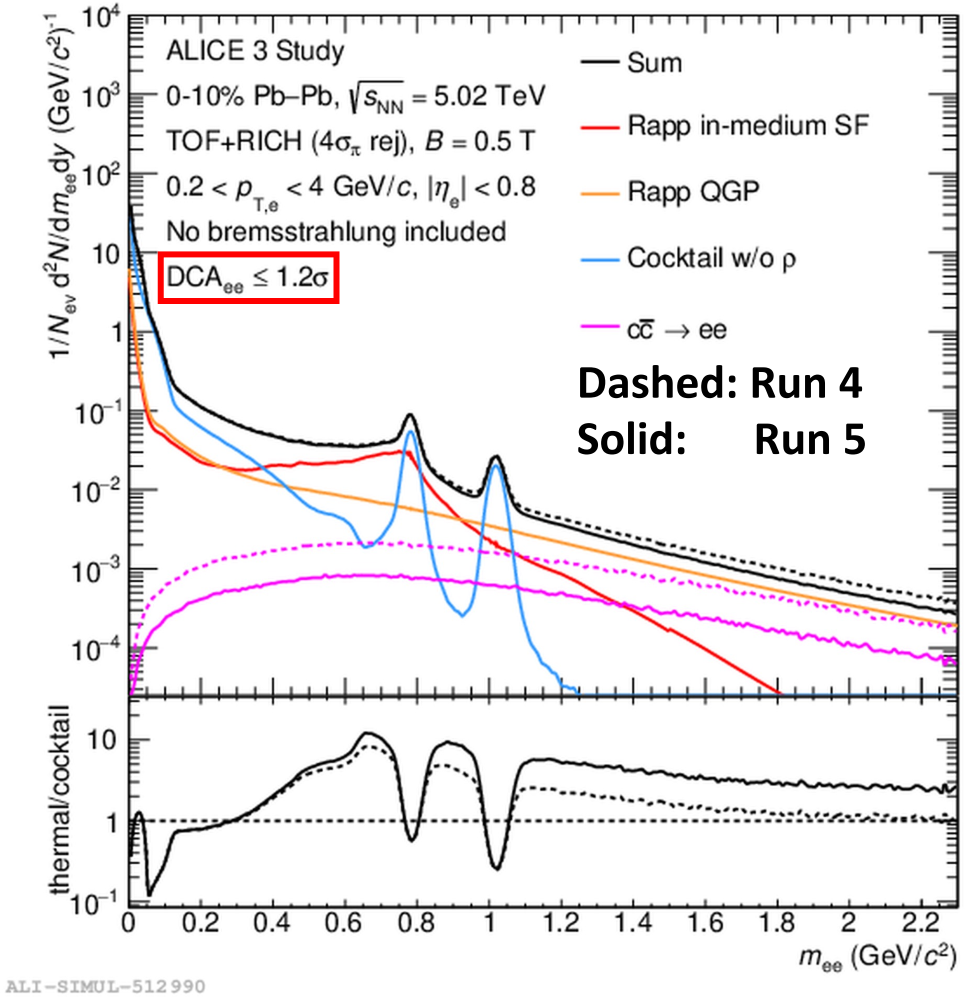
- First tracking layer closer to interaction point:
  Run 4: 18 mm
  Run 5: 5 mm
- Pointing resolution for electrons ~5x better
- Pseudorapidity coverage of $|\eta| \leq 4$

Down to low p_{T} :

- Very good electron identification
- Good tracking and reconstruction efficiency

→ Access in dielectron measurements up to $m_{\mathrm{ee}} > 3$ GeV/c^2 and low $p_{\mathrm{T,ee}}$

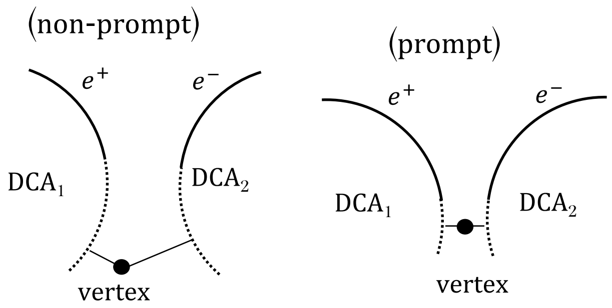
Distance of closest approach (DCA)



Contributions to the correlated dielectron yield:

- Decay of **light-flavour** hadrons (π^0,η,η′,ω and ϕ)
- Semileptonic decays of pair-produced **open charm**
- **Thermal radiation** from the **hadronic phase**
- **Thermal radiation** from the **QGP**

$$DCA_{ee} = \sqrt{0.5\left(\left(\frac{DCA_1}{\sigma_1}\right)^2 + \left(\frac{DCA_2}{\sigma_2}\right)^2\right)}$$



Selecting **DCA_{ee} < 1.2σ** is reducing the

- thermal and light-flavour contributions by 20%
- charm contribution by 94.5%
- beauty contribution by 98%

Thermal radiation becomes the dominant contribution in dielectron spectra above m_{ee} > 0.4 GeV/c^2

Combinatorial background

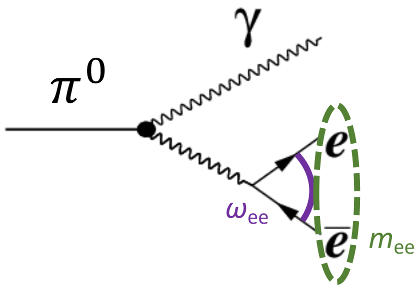
Estimated by like-sign pairing method ($e^{\pm}e^{\pm}$)

Reject combinatorics from π^0 Dalitz decays

Reject π^0 pairs with:

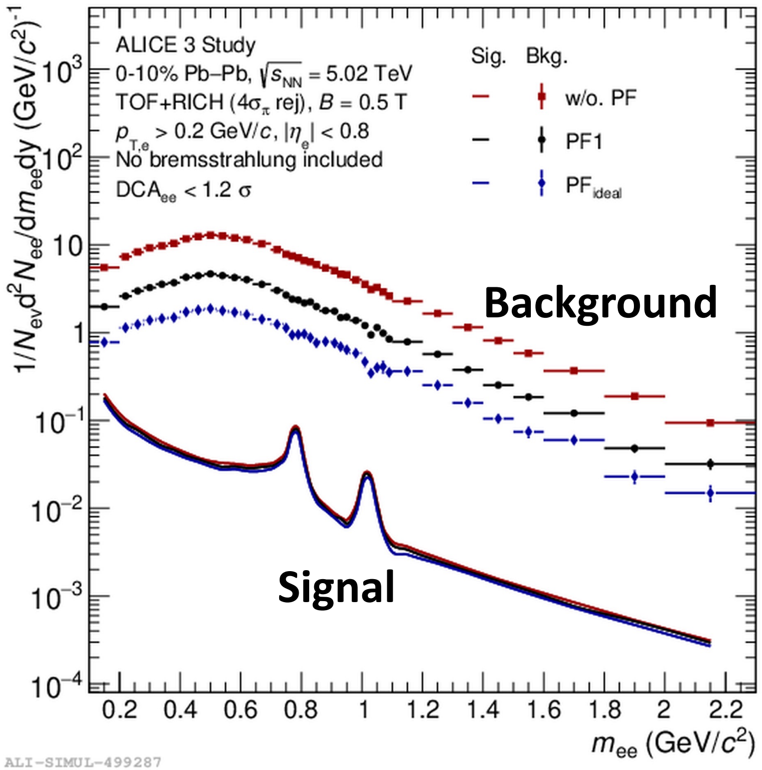
m_{ee} < 50 MeV/c^2

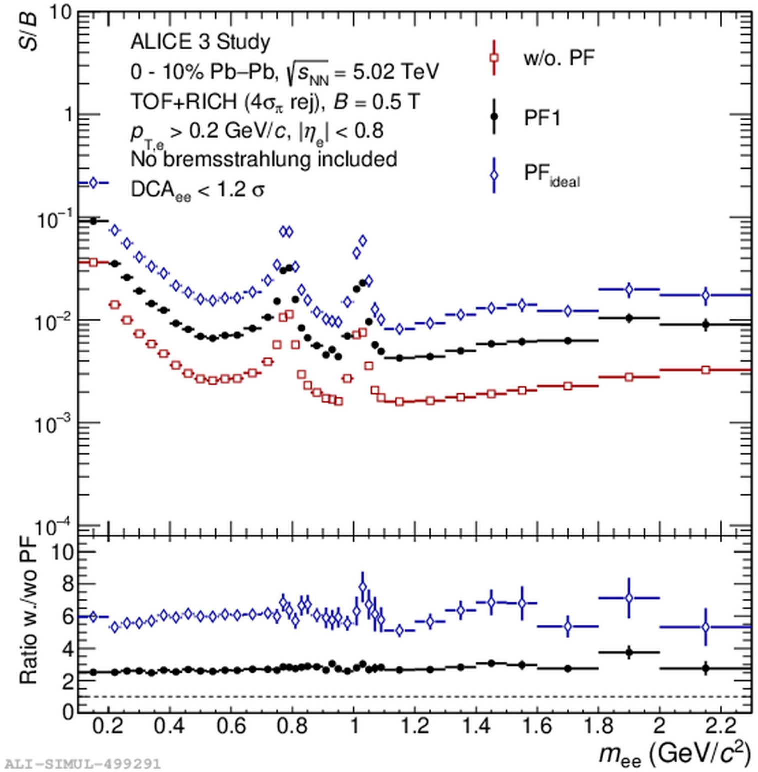
ω_{ee} < 0.1 rad



Use 3 different scenarios:

1. No prefilter
2. PF1: $p_{T,e}$ > 80 MeV/c
3. PF$_{ideal}$: $p_{T,e}$ > 20 MeV/c (use inner TOF)





Improvement of signal over background ratio by a factor ~2.5 and significance by a factor of ~1.5

Early-time temperature of the system

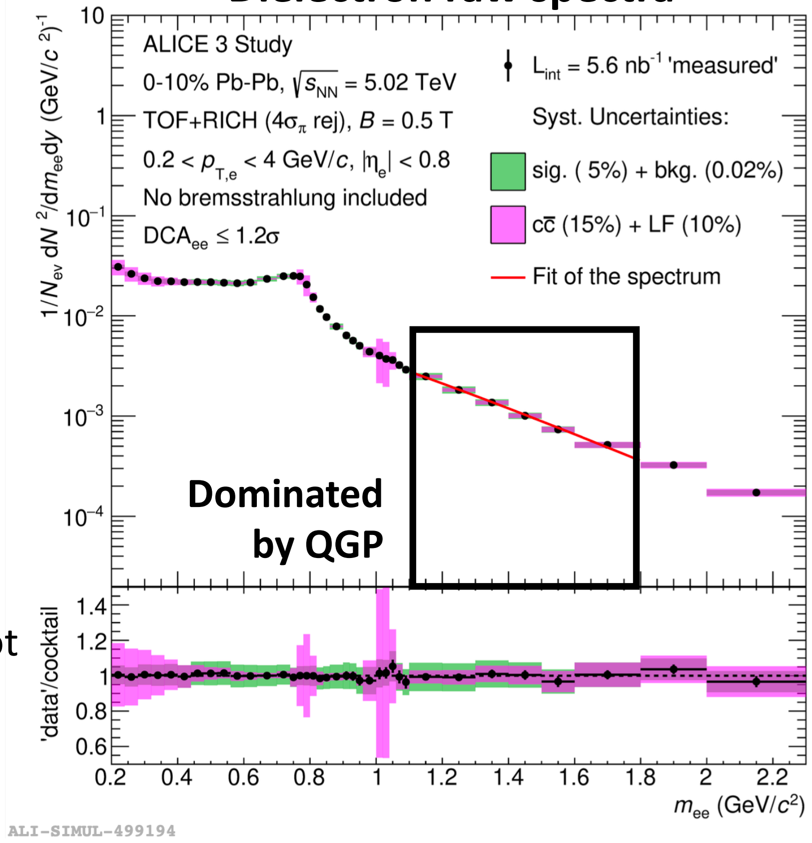
- Fit exponential function to the region of m_{ee}: 1.1 – 1.8 GeV/c^2

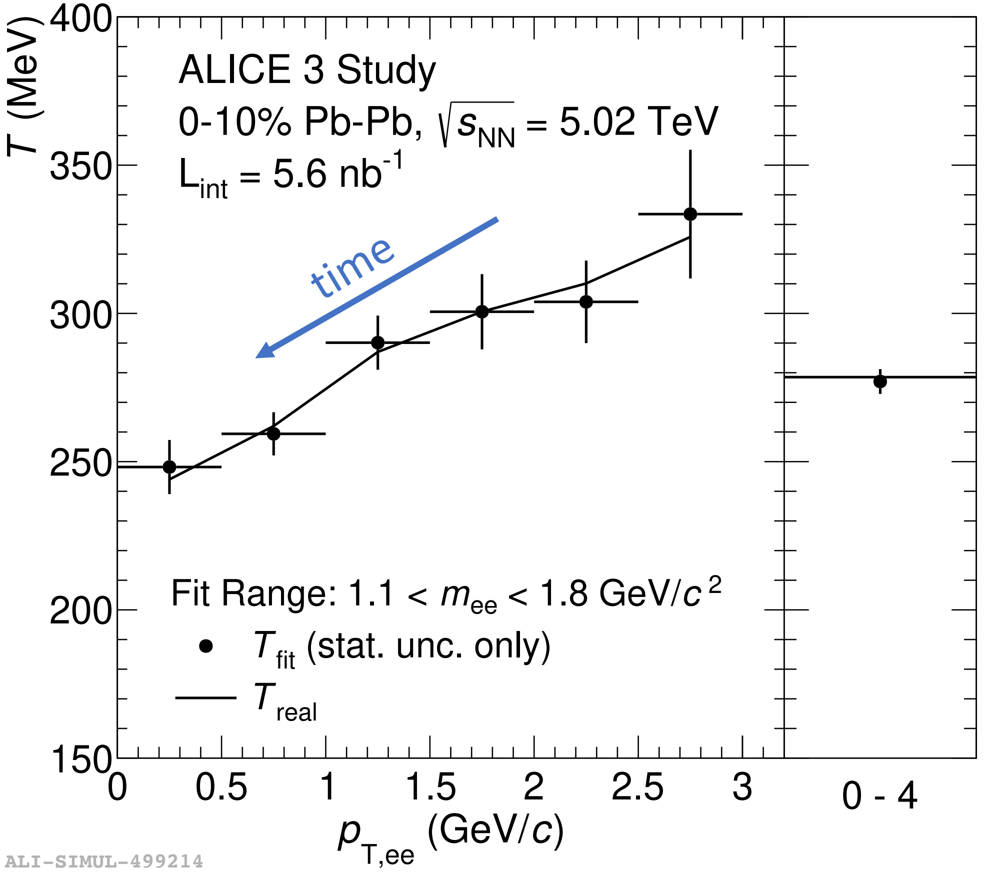
$$\mathrm{d}N_{\mathrm{ee}}/\mathrm{d}m_{\mathrm{ee}} \propto (m_{\mathrm{ee}}T)^{3/2}\exp\left(-\frac{m_{\mathrm{ee}}}{T}\right)$$

- Fit parameter T_{fit} gives estimation for early temperature of the medium
- Real temperature T_{real} estimated by fit to theory input

In Run 3/4 differential measurement not possible due to large systematic uncertainties of charm contribution

Dielectron raw spectra





Precise measurement of early temperature possible with ALICE 3

Elliptic flow

Measure thermal dielectrons in semi-central (30-50%) collisions

- Elliptic flow measured with event-plane method
- Thermal dielectrons dominate in m_{ee}: $0.65 - 0.75$ GeV/c^2 and $1.1 - 1.5$ GeV/c^2
- Extract excess v_2:

$$v_2^{\text{excess}} = \frac{(1 + N^{\text{excess}}/N^{LF})v_2^{\text{prompt}} - v_2^{LF}}{N^{\text{excess}}/N^{LF}}$$

Small statistical uncertainties for v_2 measurements