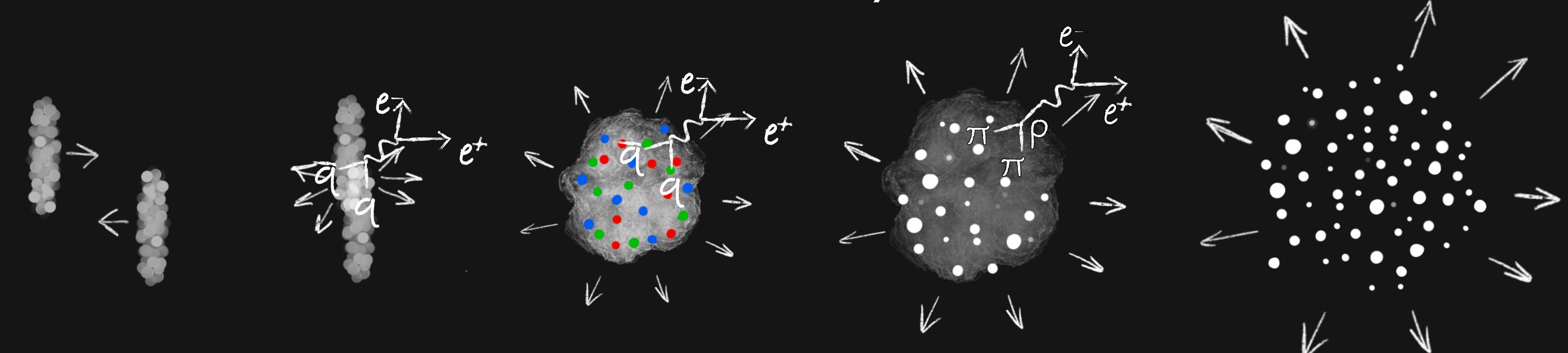
### A NEW HORIZON DIELECTRON MEASUREMENTS WITH ALICE 3 Sebastian Scheid for the ALICE Collaboration

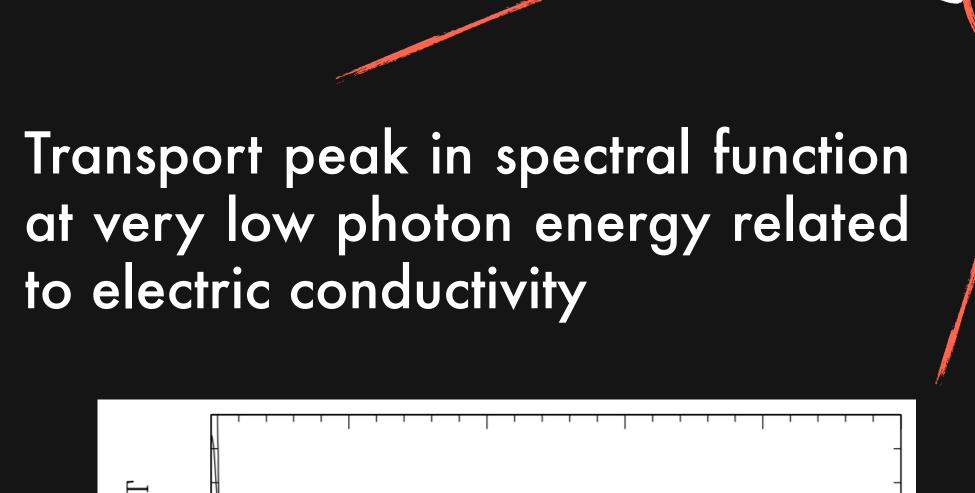


### Messengers from the Medium

Dielectrons (virtual photons) are produced in all stages of a heavy-ion collision. Since they are not interacting via the strong force, they leave the collision unscathed after their production, rendering them ideal messengers to study the whole evolution of a heavy-ion collision.

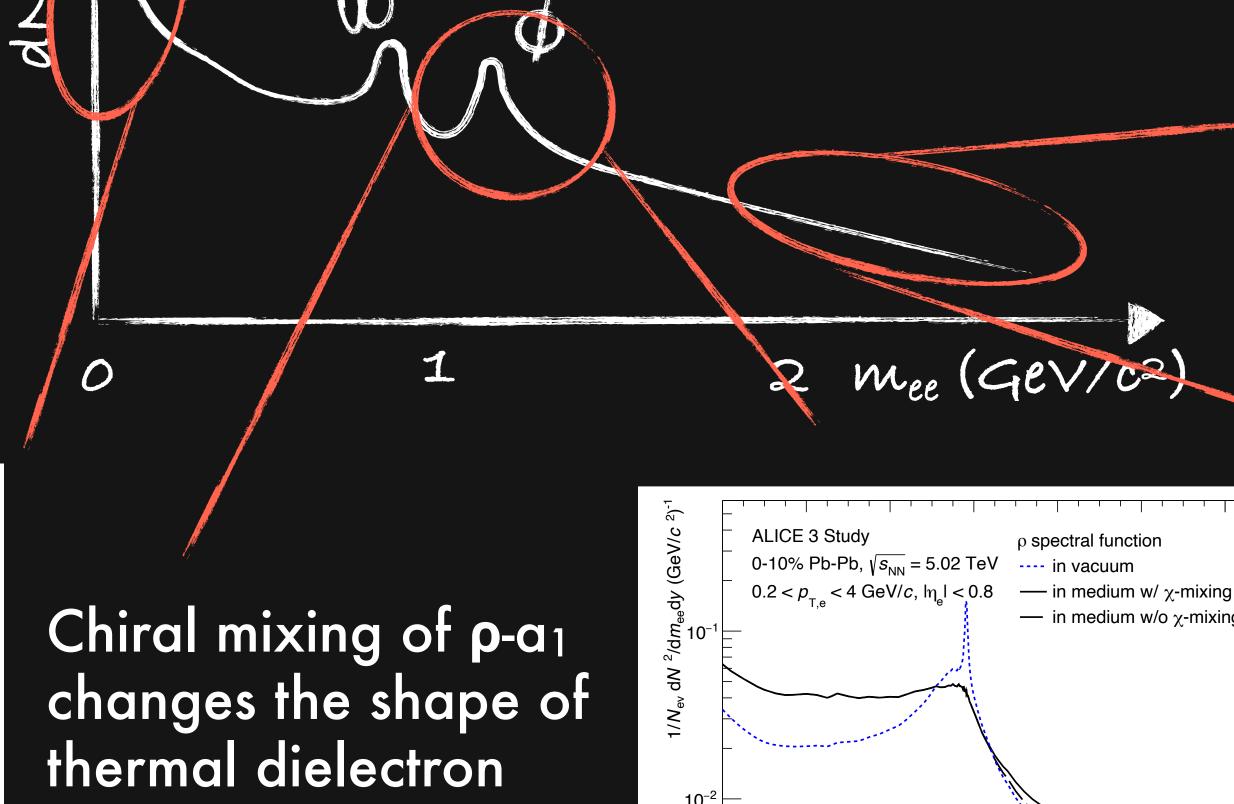


### Dielectrons beyond 2030 7

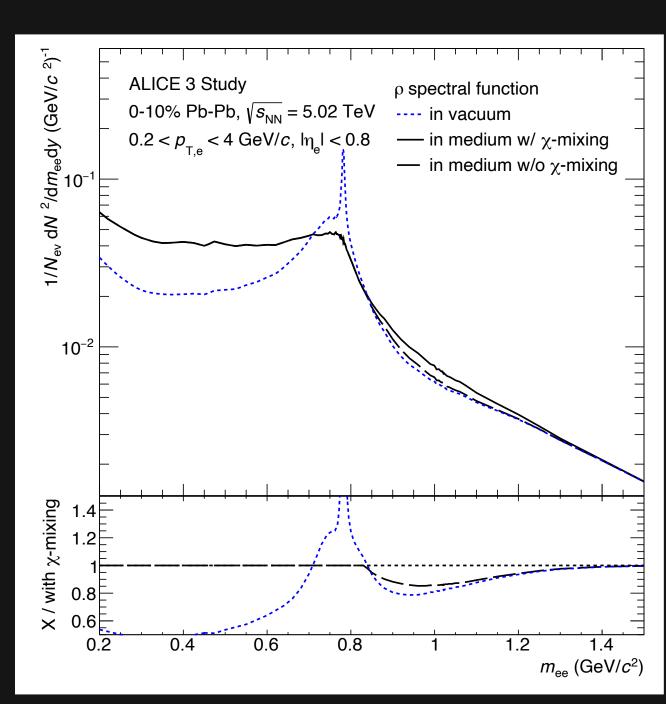


left: spectral peak at  $\alpha_{s} = 0.1, 0.2, 0.3$ Below: leading large q<sup>0</sup> Energy q<sup>0</sup>/T

strong coupling  $\alpha_s$  as a function of the virtual-photon energy normalised to the medium temperature [2].



spectrum in the mass range of  $0.9 < m_{ee} < 1.4 \text{ GeV/c}^2$ 



tematic uncertainties

uncertainties are based

stematic uncertainties

are assumed to be 5%

contribute are shown ir

--- η/s=0.32 w/o quark supp Drell-Yan EPPS Fig 2 (left) Spectral function of the ρ meson in medium with nd without chiral mixing and the vacuum expectation [3]. Fig 3 (right) Dilepton yield for different values of  $\eta/s$ , with nd without quark suppression in 0-5% Pb-Pb collisions at

hadronic probes

Sensitivity to initial anisotropies

and  $\eta/s$ , not accessible with

Pb+Pb √s<sub>NN</sub>=5.02 TeV y=0, 0-5% centrality

--- η/s=0.16 w/o quark supp

### A Next-Gen Heavy-Ion Experiment

New experiment for LHC Run 5 and 6 (start 2035)[1]

High-resolution retractable vertex detector

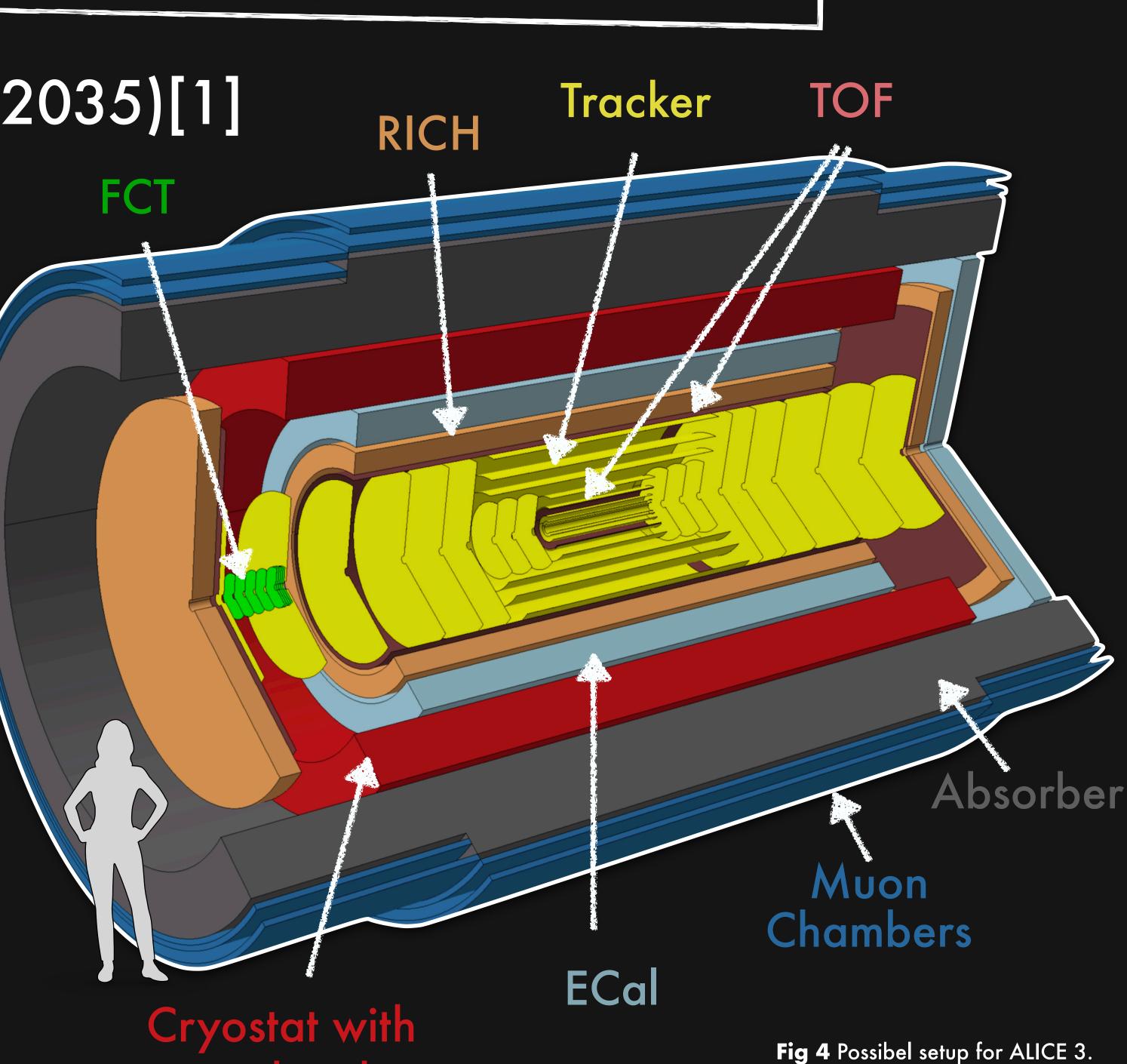
• 1st layer at 5 mm from interaction point (pointing resolution < 20 µm)

Large acceptance silicon tracker ( $|\eta| < 4$ ) Superconducting magnet system

 Good momentum resolution over whole acceptance

Large coverage for particle identification Electron Identification:

- •TOF layers (low pt)
- RICH (intermediate pt)



### Heavy-Flavour Rejection via DCA

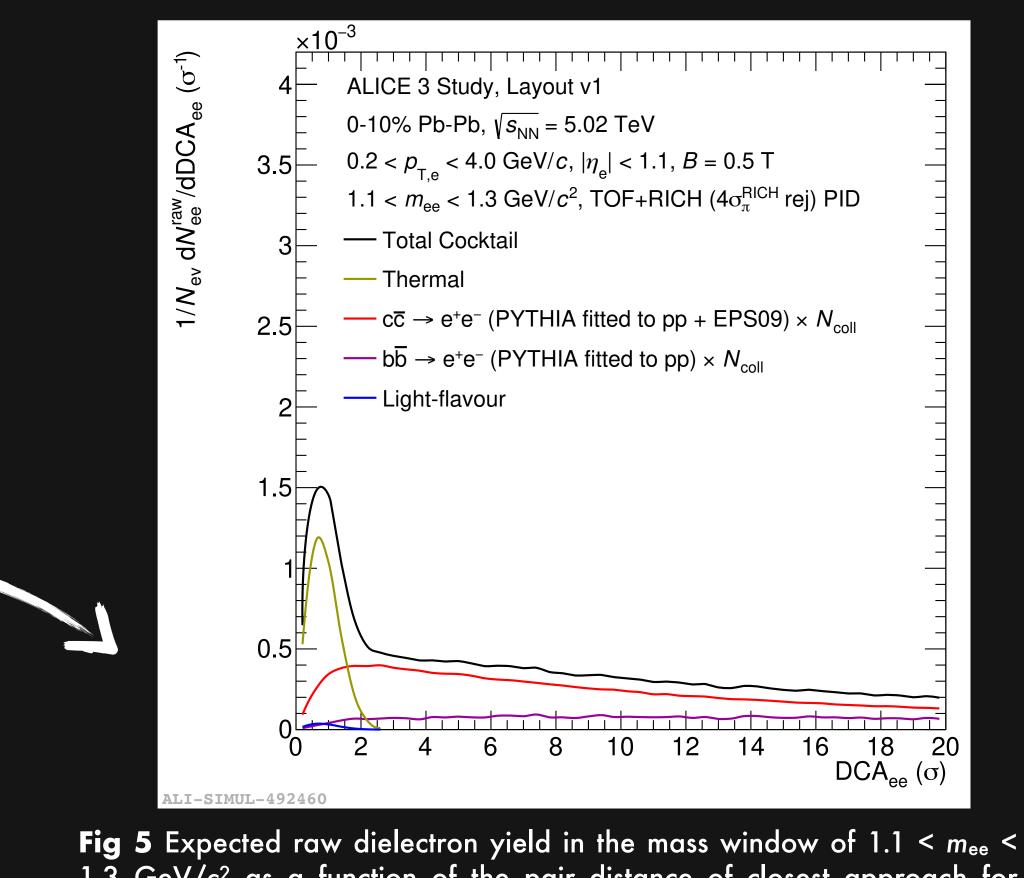
Separation of prompt and non-prompt pairs via pair Distance-of-Closest-approach DCA<sub>ee</sub>

 $DCA_1^2 + DCA_2^2$ 

Expectation:

DCA<sub>ee</sub>(prompt) < DCA<sub>ee</sub>(HF)

Separation power driven by resolution



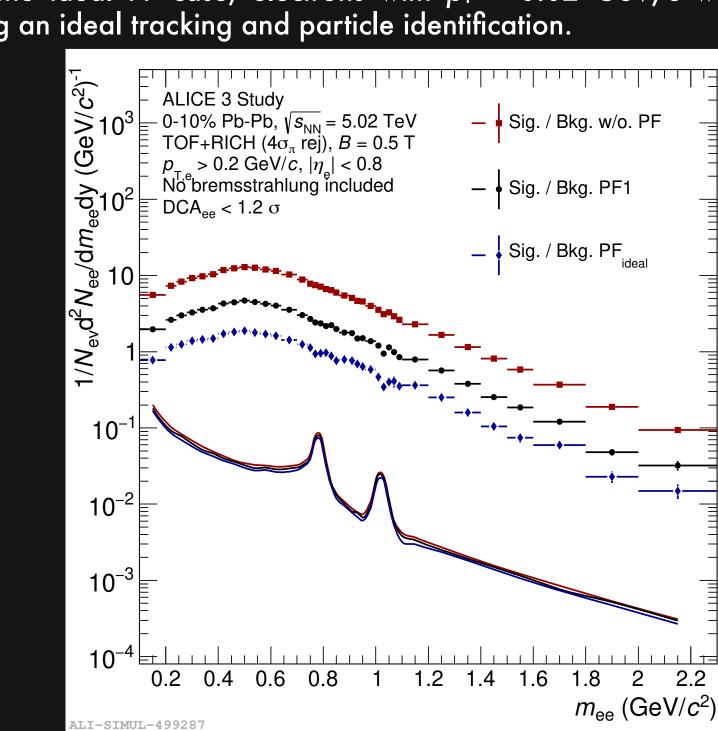
1.3 GeV/c<sup>2</sup> as a function of the pair distance of closest approach for prompt thermal dielectrons calculated by Ralf Rapp, and the contributions from light-flavour decays, as well as the decays of charm and beauty

#### Signal, Background and Prefilter

Signal based on previous measurements [5,6] and calculations by Ralf Rapp [3]

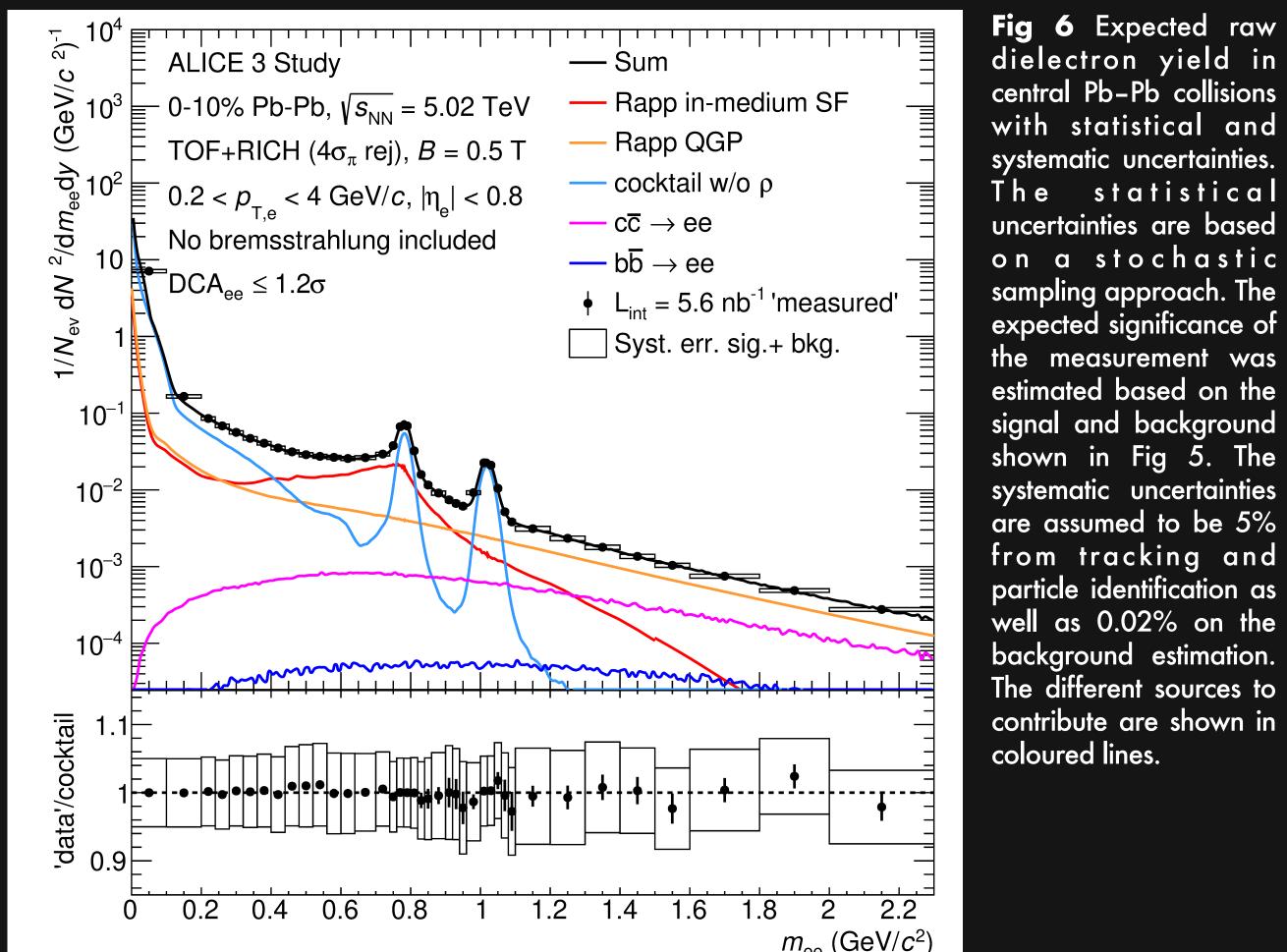
Main background sources are combinatorial pairs from different hadron decays

Fig 5 Expected signal (lines) and combinatorial background (points) as a function of the dielectron invariant mass for different scenarios of prefilters (PF). The detector response for the TOF and RICH detectors was simulated and applied. In addition, electrons with a  $p_T > 0.2$  GeV/c were selected. Only pairs with a DCA<sub>ee</sub> smaller than 1.20 were selected (rejecting HF). In the PF1 case, a pre-selection on the pair level was performed, and electrons belonging to a pair with an opening angle < 100 mrad and a  $m_{\rm ee}$  < 50 MeV/c<sup>2</sup> were rejected (mainly LF). These electrons were selected with a  $p_T$  > 0.08 GeV/c. In the ideal PF case, electrons with  $p_T > 0.02$  GeV/c were selected, assuming an ideal tracking and particle identification.



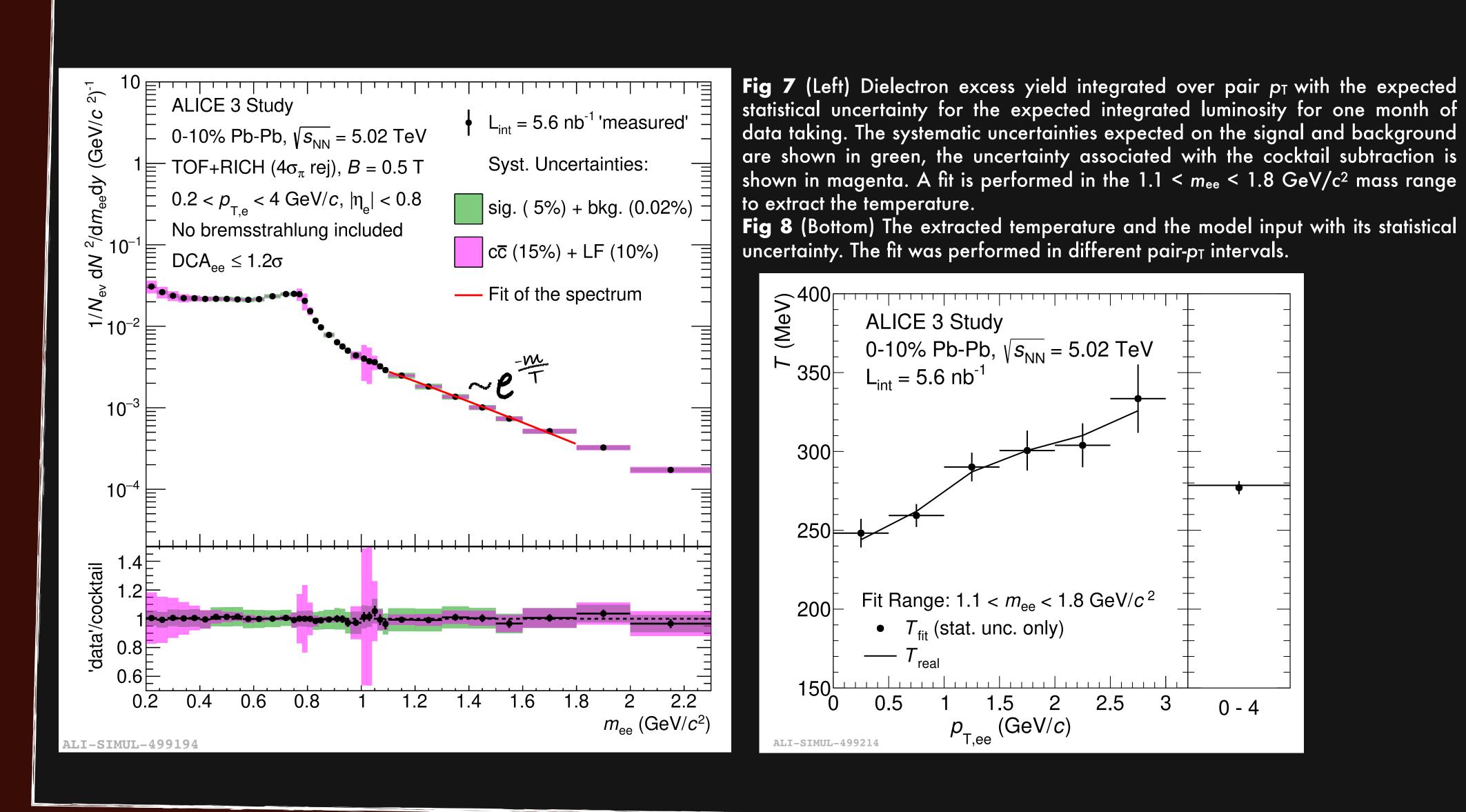
Statistical uncertainties significantly smaller than expected systematic uncertainties

After DCA<sub>ee</sub> selection thermal signal dominates over wide mass range



#### The QGP Temperature

Possibility for multi-differential analysis gives access to early stages of the collision

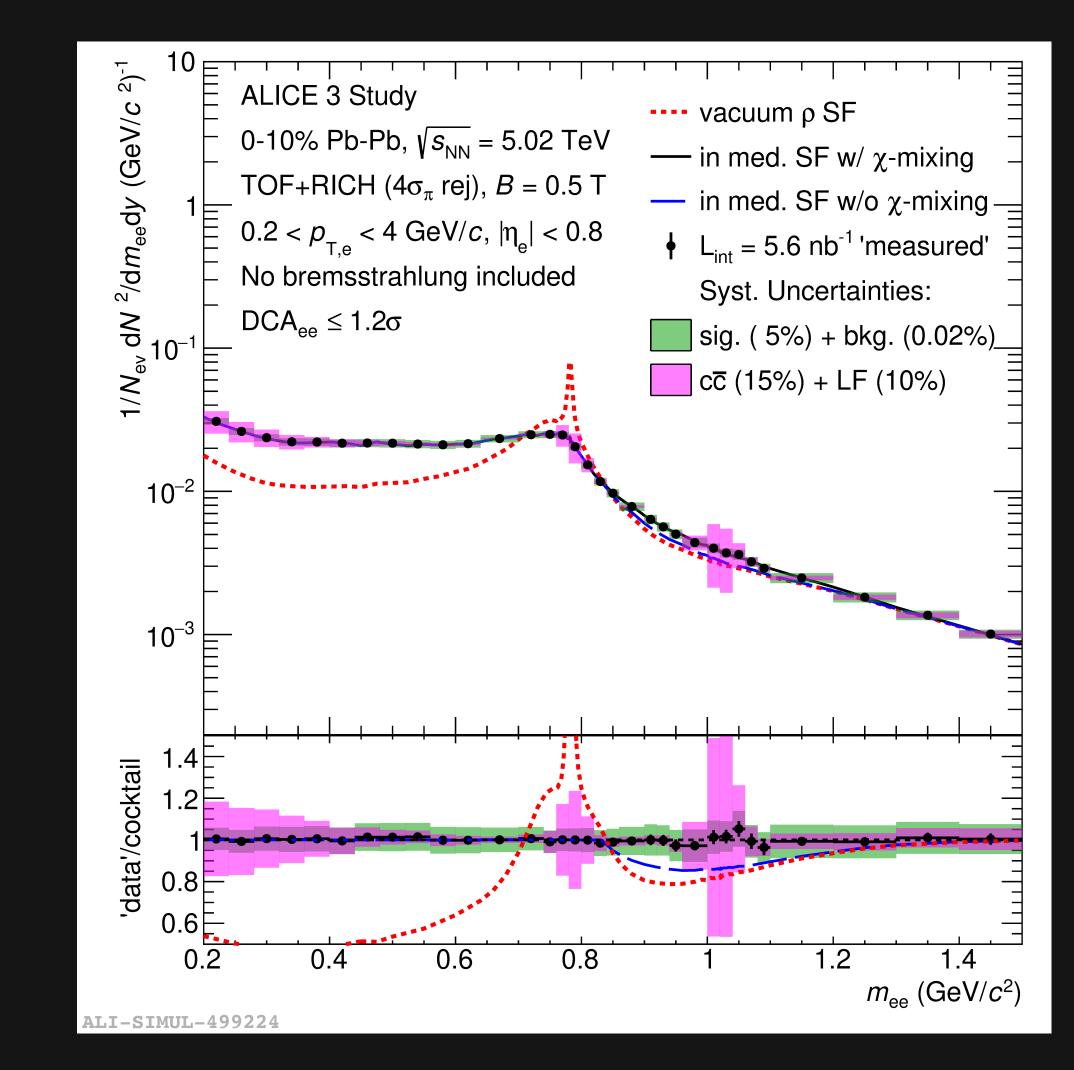


## Chiral-Symmetry

0

### Restoration

Statistical and systematic uncertainties will allow to measure the p spectral function with unprecedented precision

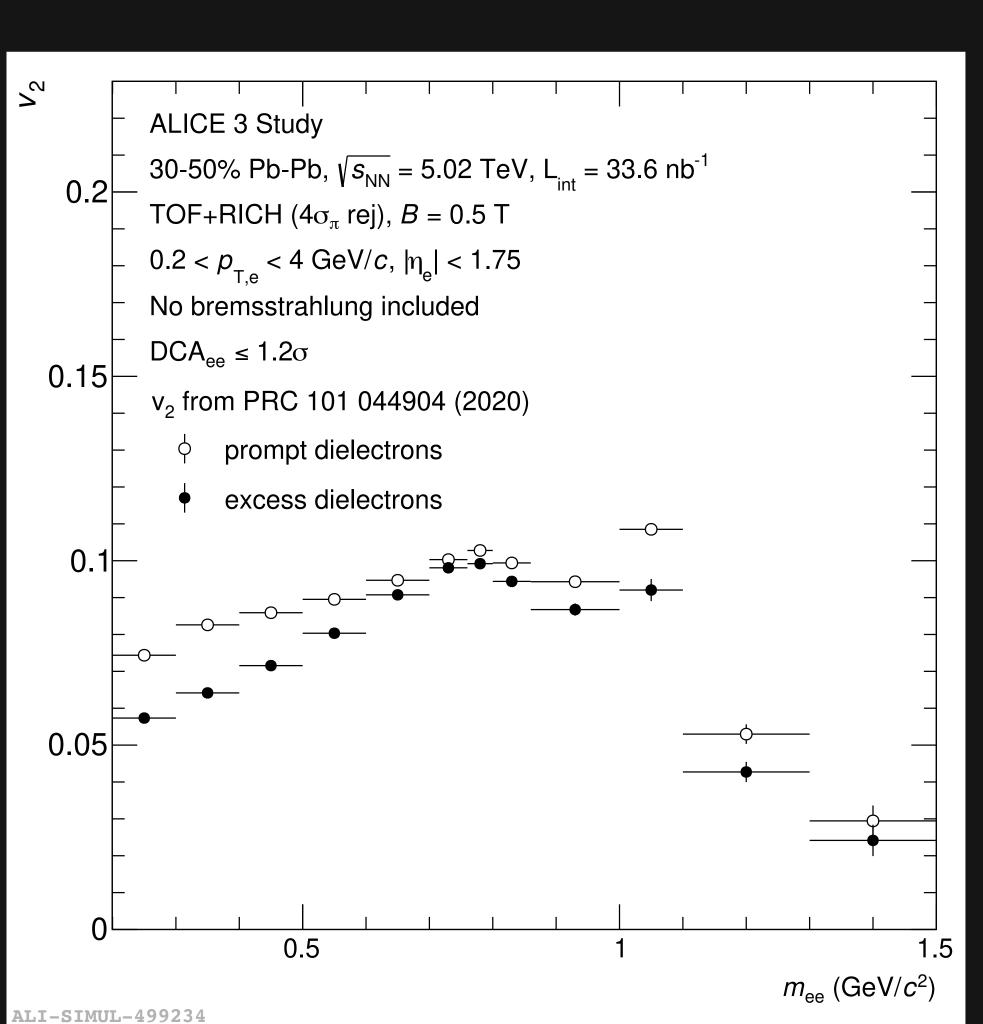


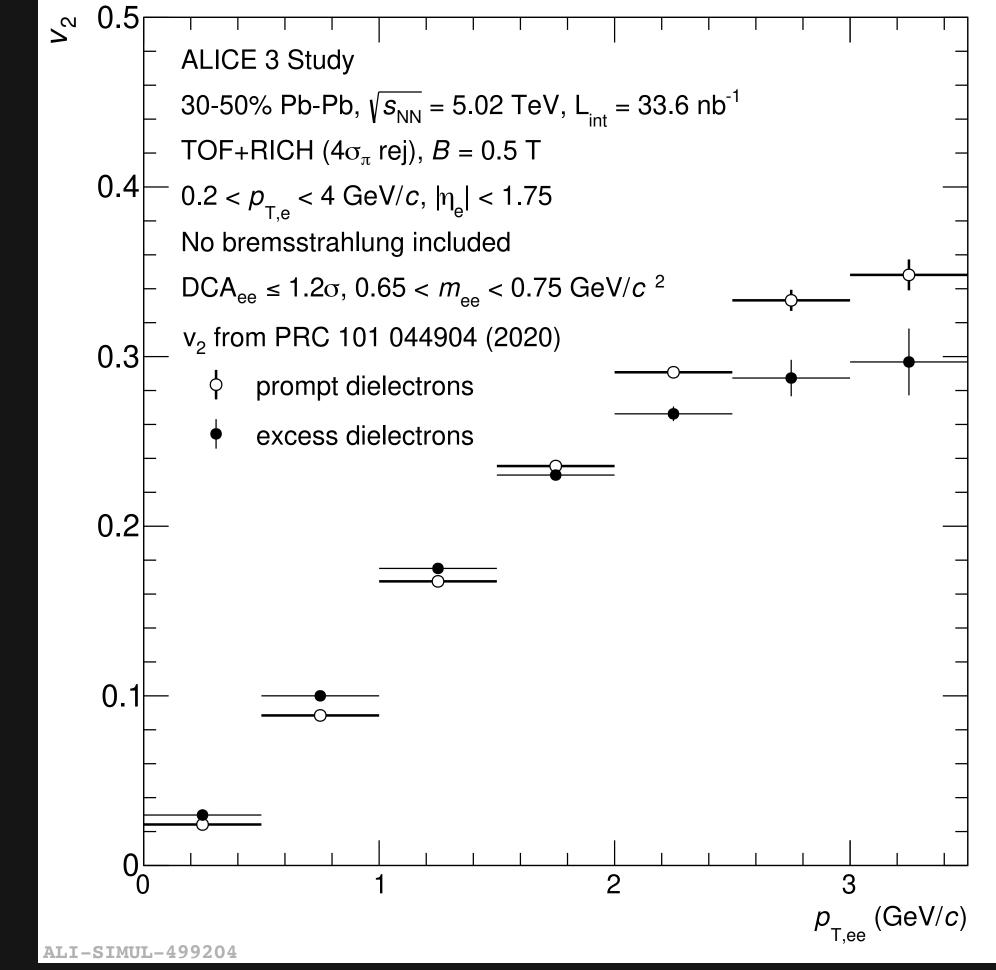
mass range of  $0.2 < m_{ee} < 1.5 \text{ GeV/c}^2$ integrated in pair  $p_T$  with the expected statistical uncertainty for the expected integrated luminosity for one month of data taking. The systematic uncertainties expected on the signal and background are shown in green, and the uncertainty associated with the cocktail subtraction is shown in magenta. The data is compared with different calculations of the spectral function (SF) of the  $\rho$ . For the calculations the medium-modified SF including the mixing of the chiral partners was used ). In addition, an in-medium SF not explicitly including chiral mixing (dashed blue), as well as the vacuum SF (dashed

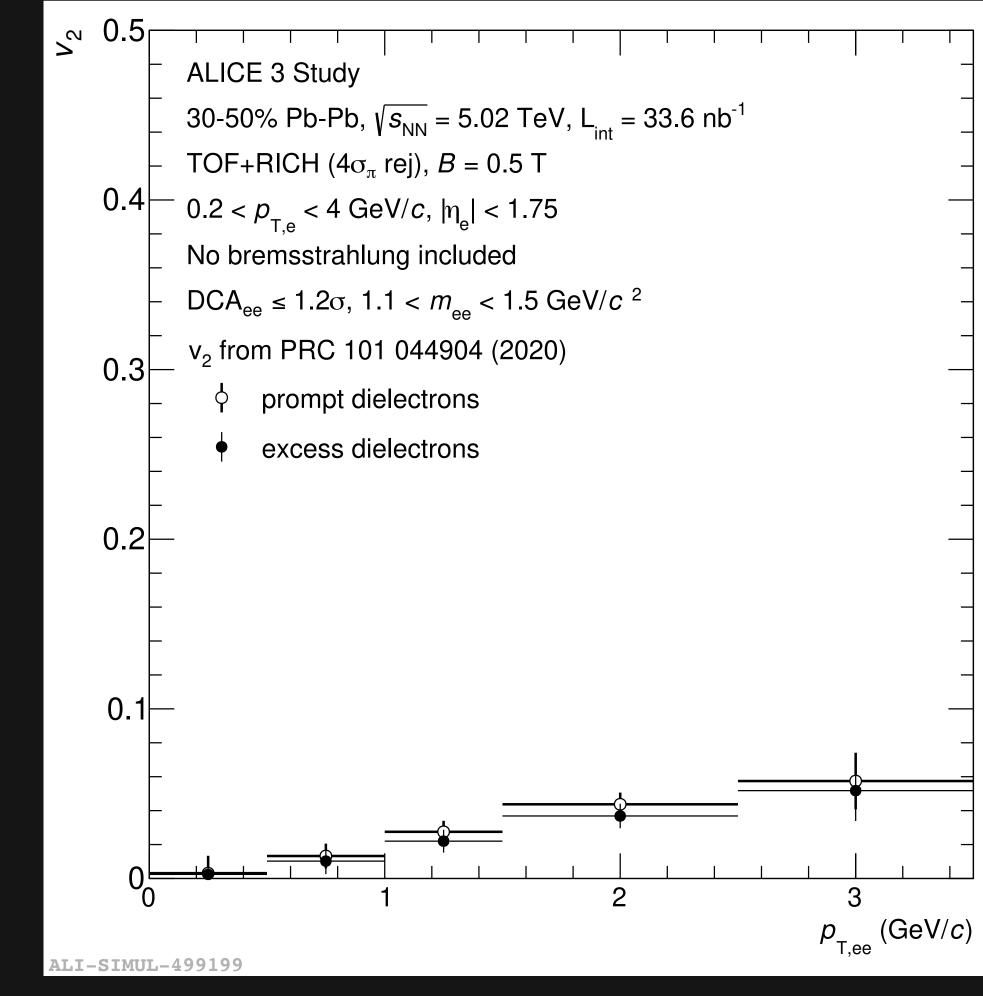
Fig 9 The dielectron excess yield in the

#### Elliotic Flows

Statistical precision of ALICE 3 will allow for multi-dimensional analysis of dielectron elliptic flow over a wide range of invariant masses and pair transverse momentum



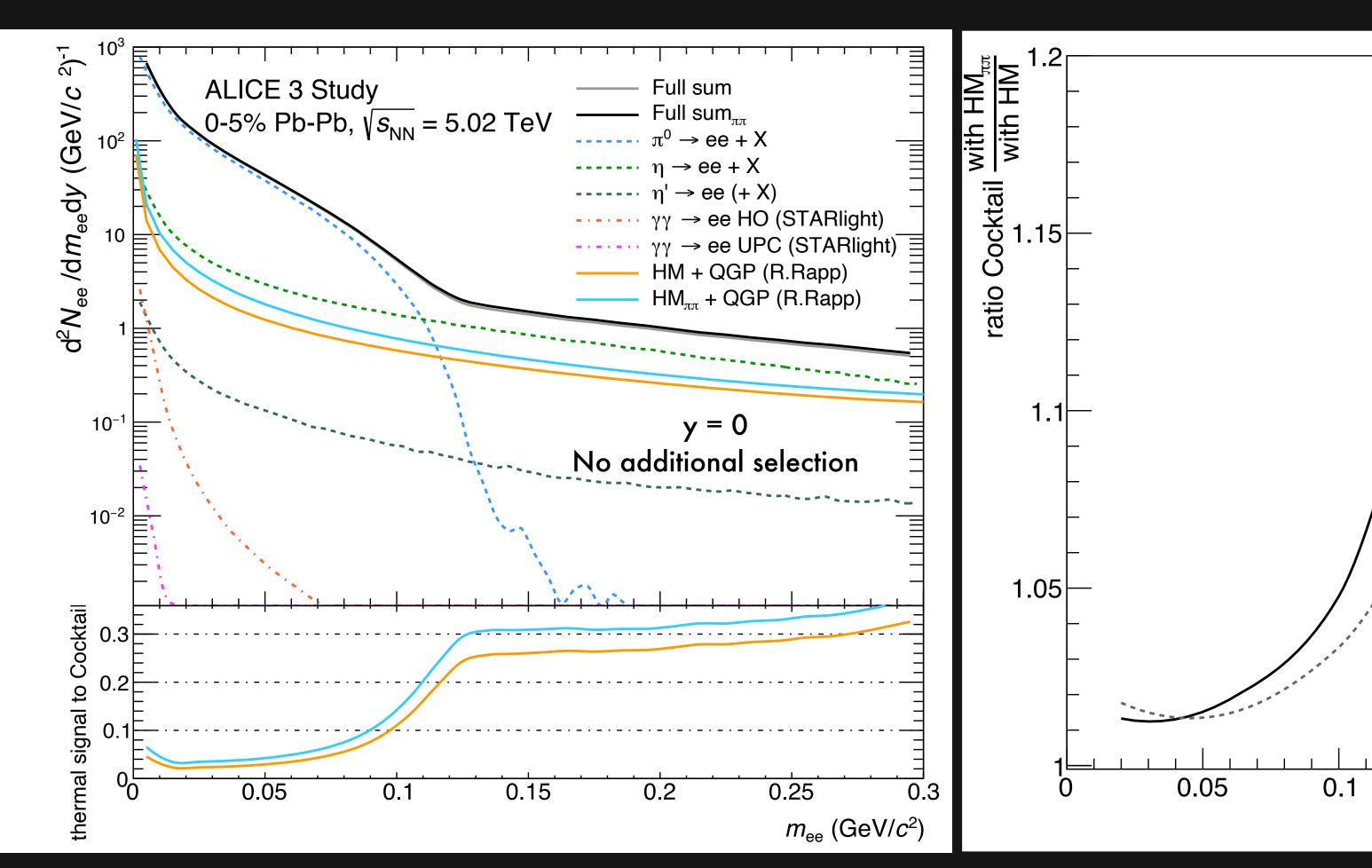


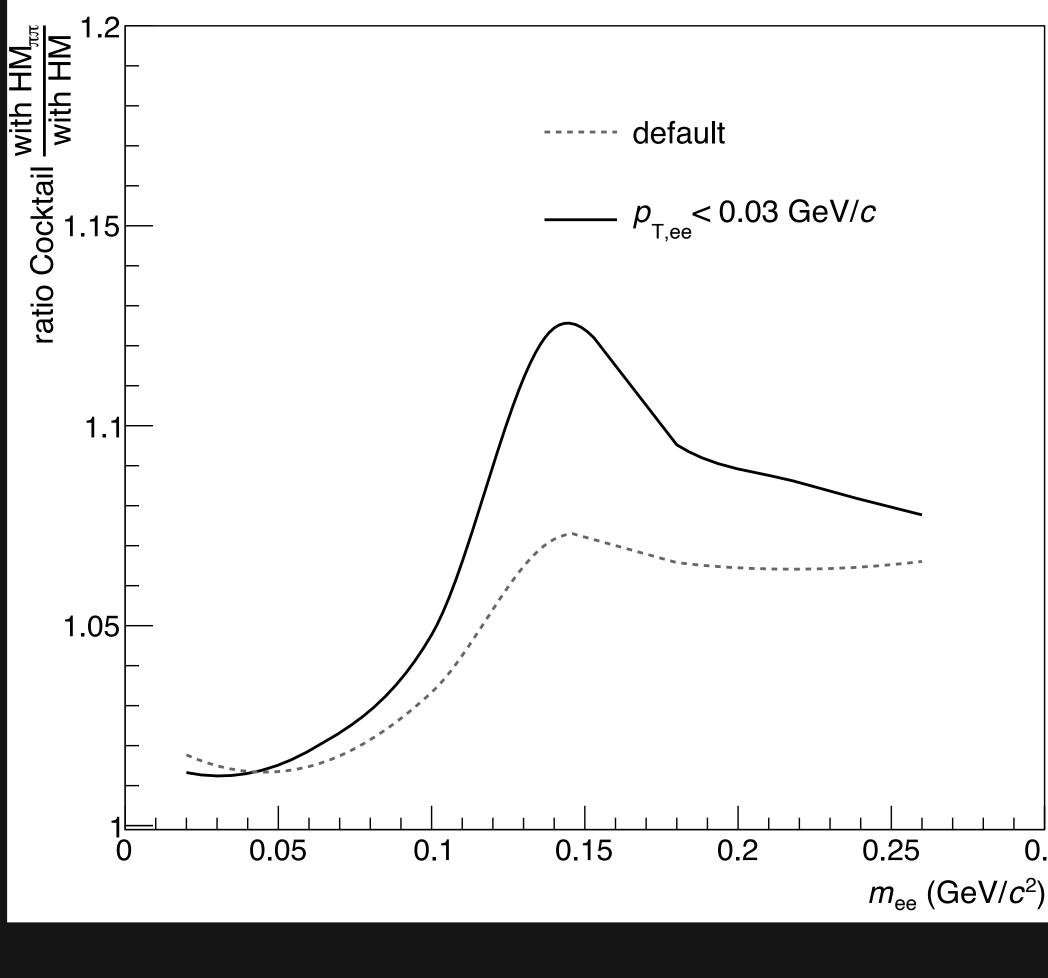


stematic uncertainties are **Fig 11** (middle) Expected elliptic flow  $v_2$  of prompt (open) and thermal (closed) dielectrons as a unction of the p<sub>T,ee</sub> in the mass ange  $0.65 < m_{ee} < 0.75 \text{ GeV/c}^2$ emi-central Pb-Pb collisions. No

### Electric Conductivity

Measurement of super soft part of thermal radiation (sensitive to electric conductivity) within reach in ALICE 3 Sensitivity can be increased by selecting softest pairs





sensitivity of a measurement from

# UNIVERSITÄT FRANKFURT AM MAIN

Quark Matter 2023

### Summary

Dielectron measurements will yield deeper understanding of properties of strongly interacting matter beyond the LHC Run 3-4 program

ALICE 3 is designed as a detector well-suited to provide detailed measurements of dielectrons in heavy-ion collisions Letter of Intent[1] received positive feedback from LHCC

Insights into the details of chiral restoration, electric conductivity as well as multi-differential analysis of the QGP temperature and thermal photon elliptic flow in reach

#### References

[1] ALICE Collaboration, CERN-LHCC-2022-009, arXiv: 2211.02491. [2] G. D. Moore and J.-M. Robert, arXiv:hep-ph/0607172

[3] Ralf Rapp, private communication, based on R.Rapp and J.Wambach, Eur. Phys. J. A6 (1999)415; H.van Hees and R. Rapp, Nucl Phys. 806 (2008) 339;

R. Rapp, Adv. High Energy Phys. 2013 (2013) 148253. [4] M. Coquet et al., Phys. Lett. B 821 (2021) 136626.

[5] ALICE Collaboration, Phys. Rev. C 101 (2020), 044907. [6] ALICE Collaboration, Phys. Lett. B 804 (2020), 135377. [7] S.R. Klein et al., Comp. Phys. Comm. 212 (2017) 258.

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