Prospects of Low-Mass Dielectron Measurements in ALICE with an upgraded Central Barrel Detector*

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The measurement of electron-positron pairs in the low invariant mass region allows to study the vacuum and in-medium properties of light vector mesons. Dielectrons also probe the production of thermal photons in heavy-ion collisions. ALICE is well-suited to perform this measurement due to its excellent tracking and particle identification capabilities at very low momenta. However, Dalitz decays and photon conversions lead to a high combinatorial background. Additionally, coincident semi-leptonic decays of charm and anti-charm hadrons produce a continuum signal, which dominates over a thermal dielectron signal.

Both contributions can be reduced by an improved Inner Tracking System, to be installed during LHC's long shutdown 2 (2018). It will further improve the tracking efficiency at low p_{T} and provide excellent detection capabilities for electrons from secondary vertices like conversions and heavy-quark decays. Additionally, an upgrade of the TPC readout will substantially increase the data taking rate [1]. We present the expected impact on the low-mass dielectron measurement in Pb–Pb collisions at full LHC energy.

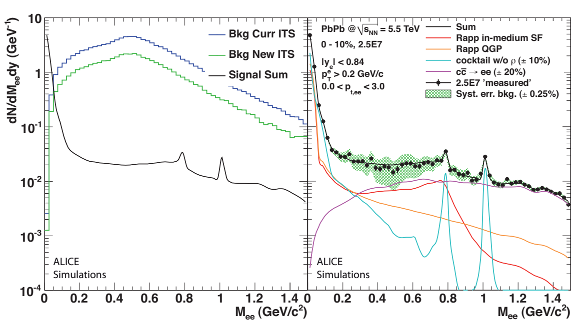

Figure 1: Left: modelled combinatorial background in central Pb–Pb collisions. Right: composition of the expected signal and sampled data points.

The electron selection is simulated using data-driven parameterizations of the TPC and TOF detectors. A reduced solenoid magnetic field of $B = 0.2$ T is assumed to increase the low-p_{T} acceptance. ITS standalone tracks are used to reject electrons from unwanted sources. The resulting combinatorial background (invariant mass distribution of like-sign pairs) is shown left in Figure 1 for both the current and planned ITS version. The right side shows the composition of the real signal, consisting of a hadronic cocktail, open charm decays, and a thermal radiation prediction [2]. Also included are 'data' points sampled according to the significance expected with the current ITS for 25M central Pb–Pb events and their systematic error.

The thermal excess spectrum is obtained by subtracting cocktail and charm and assigning estimated uncertainties as given in Figure 1. Figure 2, left panel, shows the resulting excess spectrum for the current ITS, which is dominated by systematic errors.

The planned ITS is expected to reduce the background and thus its error by a factor of about 2. Pairs from open charm decays can be suppressed by a factor of 5 using a vertex cut, at the cost of some statistics. This will be compensated with the additional TPC upgrade, as 100 times more data can be taken. The result of these improvements is seen in the right panel of Figure 2.

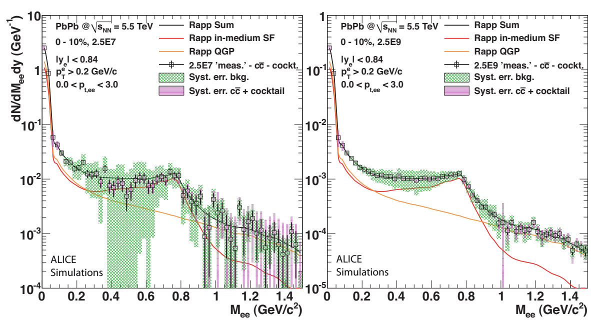

Figure 2: Left: thermal excess spectrum with current ITS for 25M events. Right: same with planned ITS for 2.5B events, using a vertex cut to reduce the error from charm.

Further implications of such a precise measurement of the thermal excess yield are the possibility to determine the QGP temperature by a fit to the mass region above $1\ \mathrm{GeV}/c^2$, and we find the uncertainties to be within about $10\ \%$. A more differential analysis even allows to determine the elliptic flow v_2 of dielectrons as function of mass or p_{T}, and the absolute uncertainty is expected to be of the order of $\sigma_{v_2} = 1\ \%$.

The variety of these measurements will give deeper insight into the early phase of the heavy ion collisions.

References

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* Work supported by BMBF, GSI, EMMI and HGS-HIRe

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