# Direct Photon Spectrum and Elliptic Flow in Pb-Pb Collisions with ALICE*

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With the ALICE experiment, photon measurements with an excellent precision are available via external conversions. The reconstruction of the $e^+e^-$ pairs is done with the Inner Tracking System and the Time Projection Chamber of the experiment. The conversion method provides the advantage of high tracking efficiency and excellent photon momentum resolution at low $p_T$ ($p_T < 6\,\mathrm{GeV}/c$). The direct photons yield is obtained by subtracting a cocktail of hadronic decay photons, calculated from the measured $\pi^0$ spectrum, from the measured inclusive photons. The neutral mesons are extracted from the same set of photons via an invariant mass analysis of photon pairs.

At low and intermediate $p_T$, thermal photons from a QGP and from the hadronic phase are expected to contribute significantly to the total amount of direct photons. These photons are emitted over the whole system evolution time and do not interact with the strongly coupled medium. Despite the fact that the photons are blue-shifted, they carry information about the system at their production time.

In Fig. (1) the direct photon invariant yield for the 0-40% most central Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76\,\mathrm{TeV}$ is presented. In addition, a NLO direct photon calculation for pp at $\sqrt{s} = 2.76\,\mathrm{TeV}$, scaled by the number of binary collisions and an exponential fit is shown. The inverse slope parameter of the fit ($0.8\,\mathrm{GeV}/c < p_T < 2.2\,\mathrm{GeV}/c$) is found to be $T_{\mathrm{LHC}} = 304 \pm 51^{syst+stat}\,\mathrm{MeV}$. In hydrodynamic models, in which the low $p_T$ direct photons are dominated by thermal photons, this slope parameter reflects an effective temperature averaged over the time evolution of the system.

From the direct photon excess the azimuthal asymmetry of the photon production can be extracted. Fig. (2) shows a non-zero elliptic flow in the region where the pQCD calculations fail to describe the direct photons. The magnitude is similar to the elliptic flow of charged pions. This favors similar production times of light mesons and the measured photons. In contrast, the large value for $T_{\mathrm{LHC}}$ seems to point to earlier production times when the QGP is still present. This poses a challenge for the current theoretical modelling of the time evolution of ultra-relativistic heavy-ion collisions.

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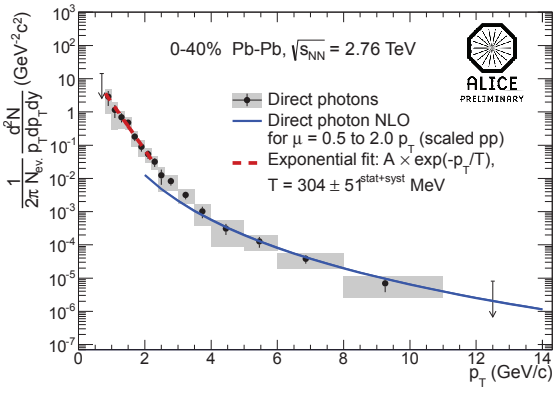


Figure 1: Direct photon invariant yield in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76\,\mathrm{TeV}$ for 0-40% centrality with pp NLO pQCD predictions scaled with the number of binary collisions and low $p_T$ exponential fit. [1]

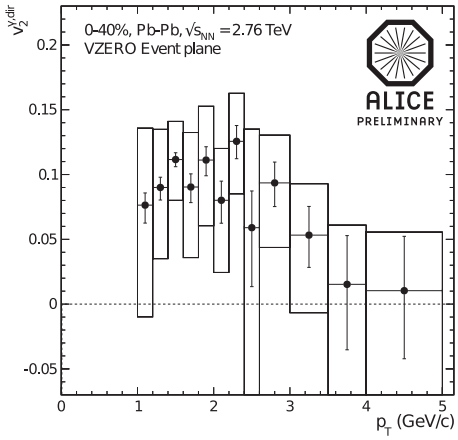


Figure 2: Direct photon elliptic flow ($v_2$) at $\sqrt{s_{NN}} = 2.76\,\mathrm{TeV}$ in 0-40% Pb-Pb collisions. [2]

## References

[1] M. Wilde [ALICE Collaboration], Quark Matter 2012 Proceeding [arXiv:1210.5958 [hep-ex]].

[2] D. Lohner [ALICE Collaboration], Hot Quarks 2012 Proceeding [arXiv:1212.3995 [hep-ex]].