Searching for photons from jets in quark gluon plasma using jet triggers

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Quark gluon plasma (QGP) is routinely created in collisions of large nuclei at very high energies, for example at the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC). Experiments at both colliders are collecting data to quantitatively characterize the properties of quark gluon plasma. Photons and jets are both important probes of QGP. Photons, once created, can escape the strongly interacting plasma due to their long mean free path and thus give unobstructed information about their origin. Very high energy quarks and gluons can also leave QGP but due to their color charge they interact strongly with the quarks and gluons in the plasma. They suffer from energy loss, mostly due to induced radiation of gluons, but the mechanism is still not fully understood. High energy quarks and gluons eventually form jets, i.e. sprays of hadrons, in the detectors.

Progress could be made if the process of energy loss of quarks and gluon due to *photon* emission could be studied with precision. This is a small fraction of the total energy loss, but because photons escape QGP unscathed the induced radiation spectrum could in principle be measured. However, there are many sources of photons in nuclear collisions and so far we have been unable to separate photon radiation induced by jets from other sources. In this project, we have looked at the possibility to detect photons from a very specific kinematic situation, namely Compton back scattering. In this process basically all the energy of the fast quark or gluon is transferred onto the radiated photon. We have studied the possibility to detect such photons using a jet on the away side (~180 degrees from the detected photon around the beam axis) as a trigger [1]. The underlying process is thus a pair of partons (quarks, gluons) created back to back with high energy. One parton escapes QGP and forms a jet which serves as a trigger. The other parton undergoes Compton back scattering with QGP and converts into a high energy photon.

We have calculated this process in various approximations, taking into account energy loss of both the trigger jet, and the parton entering the Compton process [1]. We have also computed the background from other processes, for example from jet-photon pairs created directly. We find that the signal can amount to a visible excess of photon yield for photon energies just below the window chosen for the energy of the trigger jet. The excess can be as large as 30-40%. Fig. 1 shows a typical situation for LHC energies. However, energy loss of the trigger jet can dilute the signal significantly. For realistic values of jet radii used today this makes the signal much less compelling.

Our calculation uses several conservative estimates, and it also focuses exclusively on Compton back scattering kinematics, thus ignoring part of the induced photon yield. An improved calculation, which should use a jet shower Monte Carlo as they are currently being developed, could clarify the situation.

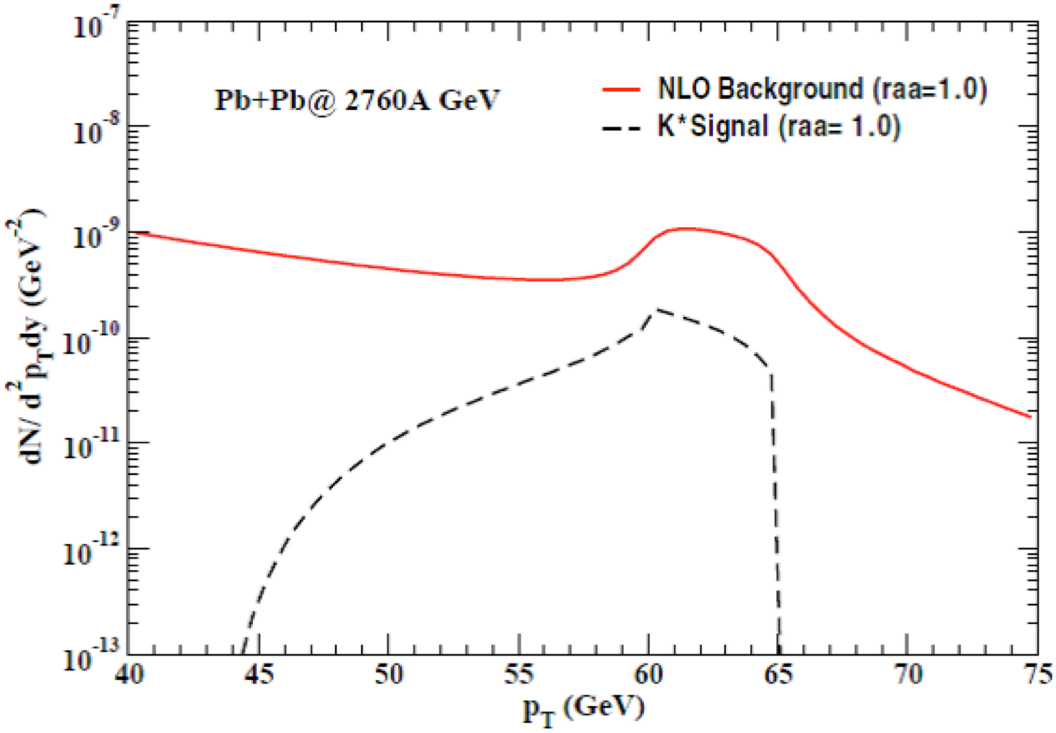

FIG. 1. The yield of photons opposite of trigger jets with an energy between 60 and 65 GeV/c for central Pb+Pb collisions at 2.76 TeV center of mass energy per nucleon-nucleon pair. Photons from Compton back scattering (black dashed line) compete with the background of photons from other processes (red solid line).

[1] Somnath De, Rainer J. Fries, Dinesh K. Srivastava, Phys. Rev. C **90**, 034911 (2014).