

Review of Habilitation Thesis of Dr. Jana Bielcikova
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This work describes the experimental work on the production of jets at the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC) by Dr. Jana Bielcikova. The measurements cover both proton-proton collisions, where the aim is to understand quantum chromodynamics (QCD) and to establish a baseline for measurements in heavy-ion collisions, and heavy-ion collisions, where the aim is to study the quark-gluon plasma (QGP), the high temperature state of QCD created in the collisions of nuclei at the LHC and RHIC. Specifically the author's aim is to perform "tomography of QGP" (quote from the abstract). She begins with an excellent broad overview of the field and then discusses the details of measurements she has been involved with including jet production in proton-proton collisions, di-hadron correlations in heavy-ion and proton-proton collisions, and jet measurements in heavy-ion collisions.

Both the European and the US long range planning for nuclear/particle physics highlights the importance of the RHIC and LHC based heavy-ion programs. The overarching goal of these programs is experimental understanding of the properties of QCD at very high temperatures. Measurements at these facilities are often grouped into two broad categories: measurements of the bulk properties of the QCD and measurement of hard probes. The second category of measurements is based on observables which include a large "hard" momentum scale. This large scale ensures that the object is produced in the earliest stages of the heavy-ion collision and thus is sensitive to the entire time evolution of the QGP. Jets are perhaps the most interesting hard probe. In jet production, a parton (quark or gluon) scatters with another parton, each from one of the incoming nuclei. In jet production, these partons exchange a large amount of momentum so the scattering angle is large. These scattered partons, which carry QCD color charge, then traverse the QGP. Differences between jet observables in heavy-ion collisions and those in proton-proton collisions are due to interactions of the jet with the QGP in heavy-ion collisions and therefore provide information about the QGP properties.

Theoretical calculations of these observables are extremely challenging due to the low-energy jets usually measured, the need to model the time evolution of the QGP, and the uncertainty of modeling the QGP-jet interactions—they key physics aim. Because of this, the gold standard is to measure systematically, an observable in heavy-ion collisions and the same observable in proton-proton collisions. In this way only the effects due to the presence of the QGP

are isolated. In this way Dr. Bielcikova's focus on jet measurements in proton-proton collisions is very important.

Early measurements at RHIC and the LHC were done using di-hadron correlations and Dr. Bielcikova was a leader in that effort. The work involving the particle species dependence of the "ridge" turned out to have especially great value as it was part of the evidence that the ridge was not a jet phenomena but was actually arising from fluctuations in the initial collision geometry and hydrodynamic flow. This marked a key paradigm shift in the field that led to the modern extractions of the QGP viscosity.

Di-hadron correlations measure either two particles from a single jet or one particle from each jet in a di-jet pair. However, jets themselves are multi-particle objects and thus measuring only two hadrons omits a lot of information. Measurements of reconstructed jets are the current standard technique. Dr. Bielcikova has been a leader in this field, serving as a convener of the relevant working groups in both STAR and ALICE as well as performing many important measurements in both collaborations. The author correctly starts with a discussion of how jet reconstruction is done in heavy-ion collisions. This is an extremely difficult environment to measure jets and the details of the technique matter a lot. The further measurements she describes are important and interesting, including the semi-inclusive jet measurements, the modifications to the jet radial profile and strangeness production in jets.

Dr. Bielcikova has long been a leader in jet physics in heavy-ion collisions. She has a strong international profile. Among her many international talks, I particularly recall a very strong summary talk given recently at the 10th International Conference of Strong and Electromagnetic Probes (June 2020, online). It was a balanced summary and made many interesting connections between new results from the conference and the previous literature. She has had served as a convener in both ALICE and STAR which shows the respect her collaborators have for her work.

In summary, I find this to be a comprehensive thesis. Heavy-ion physics is recognized to be a key area of experimental QCD. This work provides an excellent summary of the field and describes and places in context the author's own work. This work contains important contributions to the field. I recommend that it be defended in front of the Scientific Board of the Faculty.

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