The JETSCAPE collaboration

R.J. Fries

July 2016 marked the starting point of the JETSCAPE Collaboration. JETSCAPE stands for *Jet Energy-loss Tomography with a Statistically and Computationally Advanced Program Envelope*. It is a collaboration funded with $3.6M through the *Software Infrastructure for Sustained Innovation* (SI2) program of the U.S. National Science Foundation. R. J. Fries has been a PI on the proposal and is representing Texas A&M University in this multi-institutional effort. The other PIs are located at Duke University, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, McGill University, MIT, Ohio State University, UC Berkeley and Wayne State University.

JETSCAPE is a naturally following up with efforts of the JET collaboration, however it focuses mostly on computational aspects. The goal of the collaboration is to devise the next generation of event generators to simulate the physics of ultra-relativistic heavy-ion collisions with a focus on high momentum probes and jets. It involves theoretical and experimental physicists, computer scientists, and statisticians.

The JETSCAPE Collaboration will develop a scalable and portable open source software package to replace a variety of existing codes. The modular integrated software framework will consist of interacting generators to simulate (i) wave functions of the incoming nuclei, (ii) viscous fluid dynamical evolution of the hot plasma, and (iii) transport and modification of jets in the plasma. Integrated advanced statistical analysis tools will provide non-expert users with quantitative methods to validate novel theoretical descriptions of jet modification, by comparison with the complete set of current experimental data. To improve the efficiency of this computationally intensive task, the collaboration will develop trainable emulators that can accurately predict experimental observables by interpolation between full model runs, and employ accelerators such as Graphics Processing Units (GPUs) for both the fluid dynamical simulations and the modification of jets. The collaboration will create this framework with a user-friendly envelope that allows for continuous modifications, updates and improvements of each of its components. The effort will serve as a template for other fields that involve complex dynamical modeling and comparison with large data sets. It will open a new era for high-precision extraction of the internal structure of the Quark-Gluon Plasma with quantifiable uncertainties.

The design of the software framework is well under way and a first version of the JETSCAPE package is expected for late summer 2017. In the meantime, the collaboration published first physics results [1] that test the coupling of different jet shower Monte Carlo (MC) codes. The partons initiating jets are produced far off shell, measured by their virtuality Q. Jet shower MC codes so far have either focused on the virtuality evolution from large to intermediate/small virtuality, or on the energy evolution for moderately off-shell particles. The MARTINI MC code by the McGill group and LBT by the Berkeley/CCNU group are examples of the latter, while MATTER, developed at Wayne State, and vacuum shower MCs used in High Energy Physics, like PYTHIA, compute the virtuality evolution. A comprehensive description in heavy ion collisions must reconcile the high-Q and intermediate/low-Q part of the evolution. Fig. 1 shows spectra resulting from matching MATTER and LBT, together with results obtained from running individual codes. Different matching scenarios are employed, see Ref. [1] for details. Interesting new effects have been observed in this work, most notably in the distributions of angles of partons with respect to the jet axis, which qualitatively agree with experimental observations.

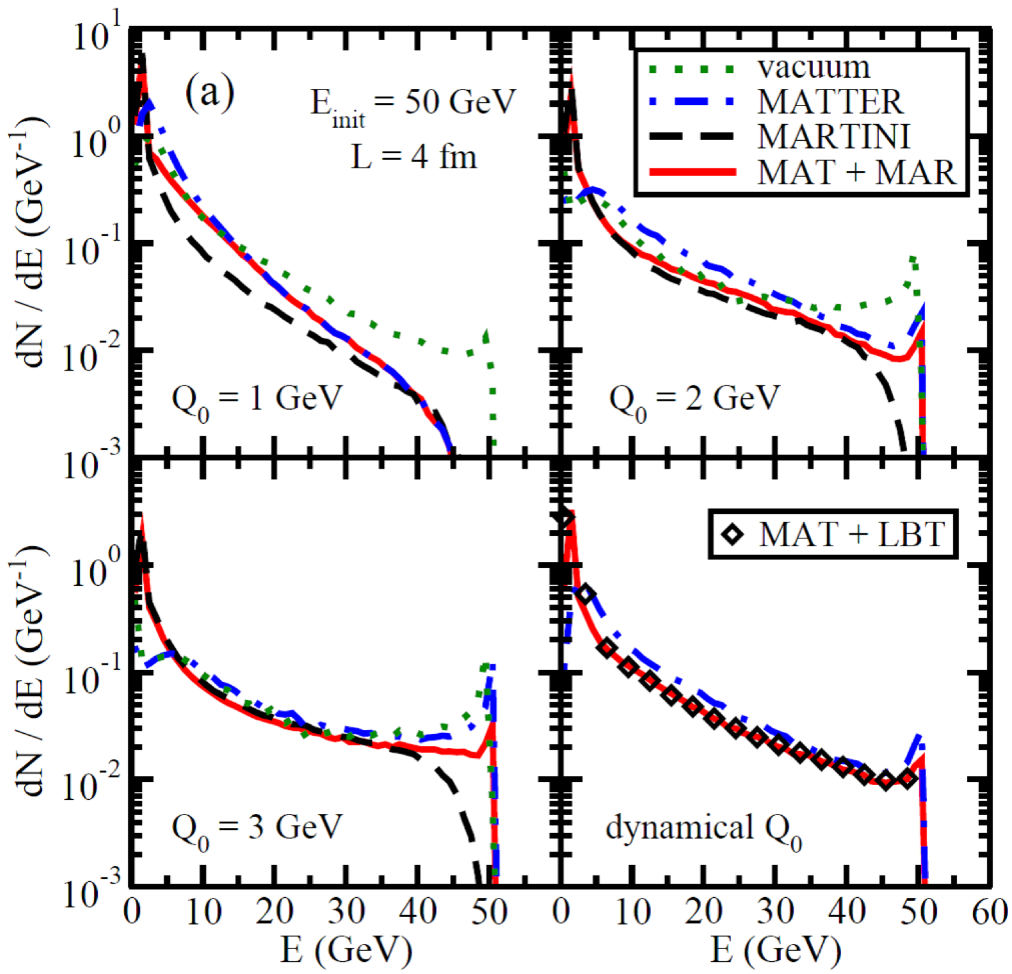

FIG. 1. Energy distribution dN/dE of partons in 50 GeV jets travelling through a brick of quark gluon plasma of size 4 fm and temperature 250 MeV. Results for vacuum jet shower evolution in MATTER (green dots), in-medium evolution with MATTER (blue dash-dots), in-medium evolution with vacuum shower plus MARTINI (black dashes) and the combination of in-medium MATTER showers with in-medium LBT evolution (black dots) are shown for 4 different matching scenarios. Q_0 denotes the virtuality scale at which vacuum or MATTER evolution ends, and MARTINI or LBT evolution starts. Figure taken from Ref. [1].

[1] S. Cao *et al.* (JETSCAPE Collaboration), Phys. Rev. C (Submitted); e-Print: arXiv:1705.00050 [nucl th].