The JETSCAPE collaboration: Recent updates and v3.0 release

R.J. Fries, Byunggyu Kim, Michael Kordell, and JETSCAPE Collaborators

We have previously reported on the first release of the JETSCAPE framework package (2018) [1] and the comprehensive study of jet observables in p+p collisions with JETSCAPE 1.0 and the JETSCAPE PP19 tune (2019) [2]. 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. It involves theoretical and experimental physicists, computer scientists, and statisticians. R. J. Fries has been a PI on the proposal and is representing Texas A&M University in this multi-institutional effort.

Funding for the original proposal ends in 2020 and the current reporting period saw the release of the last major evolution of the JETSCAPE framework as version 3.0 [3]. v3.0 packs all the physics promised in the original proposal. Improvements and new additions include: (a) the hadronic transport model SMASH which can be used as an afterburner to fluid dynamic simulations in the soft sector; (b) the LIQUIFIER module which simulates the deposition of energy from jets into the background modelled by fluid dynamics; (c) 2-step running to simulate the effects of energy and momentum deposition into the medium enabled by the addition of the LIQUIFIER module; (d) improvements to hybrid hadronization; (e) improved user friendliness through a new XML structure.

With the initial p+p study published the focus of simulations has turned to nucleus-nucleus collisions. A tuning of the soft sector (initial conditions + fluid dynamics + hadronic afterburner) using a Bayesian analysis and tens of millions of CPU hours is currently being readied for publication. First jet results in A+A have been shown at conferences and will be officially released soon. JETSCAPE has also held three schools so far, focusing on students and young postdocs. In 2019 this school was hosted by Texas A&M with support from the Cyclotron Institute.

One of the contributions from members at Texas A&M has been the addition of color flow information into the Hybrid Hadronization model used in JETSCAPE. Color flow is important information for dilute systems of quarks and gluons about to hadronize. This has been established in measurements of e^++e^- and p+p collisions. This information is obscured in A+A collisions by the presence of a color bath. Hybrid Hadronization can take complete (e.g. in p+p) or partially available color flow information, compute recombination probabilities consistently with this color flow, and form remnant strings between quarks and gluons based on the initial color flow modified by recombination. A very simple example for a single string is discussed in Fig. 1. The improvement in the handling of color flow improves the description of dilute systems like e^++e^- and p+p, and p+A collisions.

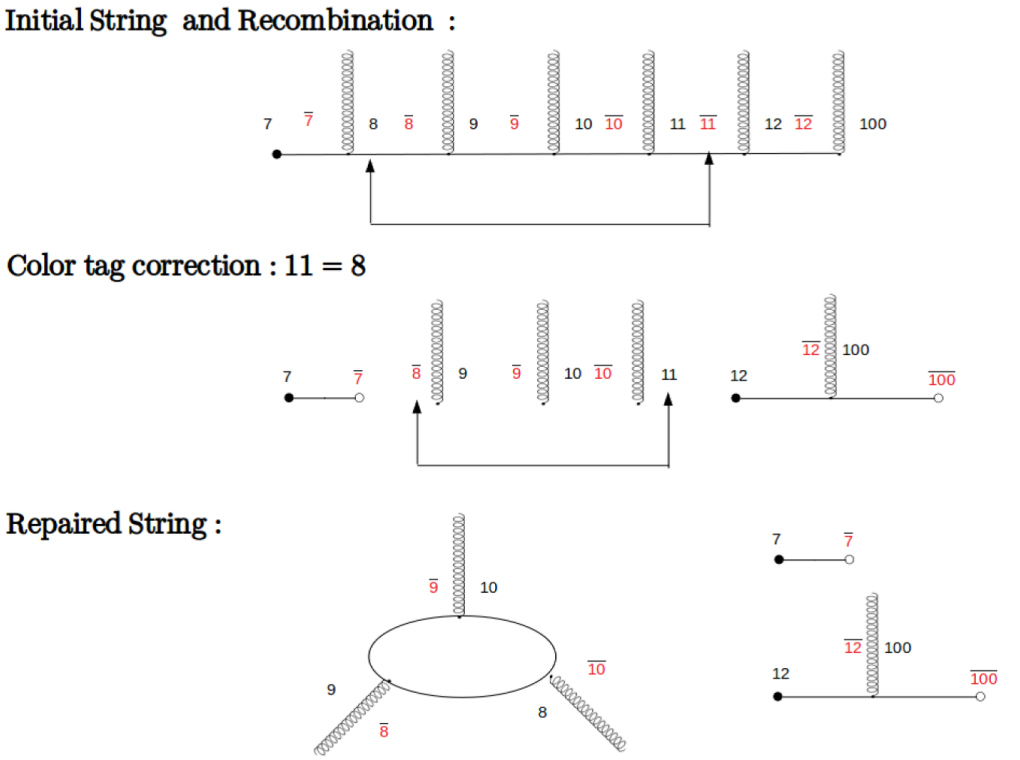

Fig. 1. New color flow in Hybrid Hadronization for a jet shower initiated by a quark with color tag 100 (top row). A quark and an anti-quark from decayed gluons with color tags and 8 and 11(bar) recombine into a meson (center row). The final string configuration after recombination consists of a gluon loop and two smaller strings which are given to PYTHIA 8 for string fragmentation. An anti-quark with color tag 100(bar) has to be added to make the system a color singlet (bottom row).

[1] J. Putschke *et al.* (JETSCAPE Collaboration), arXiv:1903.07706.

[2] A. Kumar *et al.* (JETSCAPE Collaboration), arXiv:1910.05481.

[3] The JETSCAPE 3.0 package, https://github.com/JETSCAPE.