The JETSCAPE collaboration: X-Scape and more JETSCAPE physics

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In previous versions of this report we have discussed the inception and successful launch of the JETSCAPE collaboration and their product, a flexible and modular event generator that simulates collisions of nuclei at very high energies [1]. JETSCAPE stands for *Jet Energy-loss Tomography with a Statistically and Computationally Advanced Program Envelope*. Its initial funding consisted of $3.6M from the *Software Infrastructure for Sustained Innovation* (SI2) program of the U.S. National Science Foundation. The collaboration involves theoretical and experimental physicists, computer scientists, and statisticians at various institutions around the U.S. R.J. Fries has been a PI on this project from the first minute. In 2020 the NSF has approved the *X-Scape* project as the follow-up project for the JETSCAPE collaboration with total funding of $4M. The X-Scape project will build on the existing software framework and make it more comprehensive and powerful. The new project will allow users to simulate lower energy nuclear collisions as well as proton-nucleus and electron-nucleus collisions. Thus X-Scape will offer much needed capabilities to support experiments at the Electron-Ion Collider, the next-generation nuclear physics experiment planned by D.o.E. at Brookhaven National Laboratory for 2030 and beyond. The new project has also added more institutions and PIs to the project. Fig. 1 shows a schematic flow diagram for the X-Scape framework.

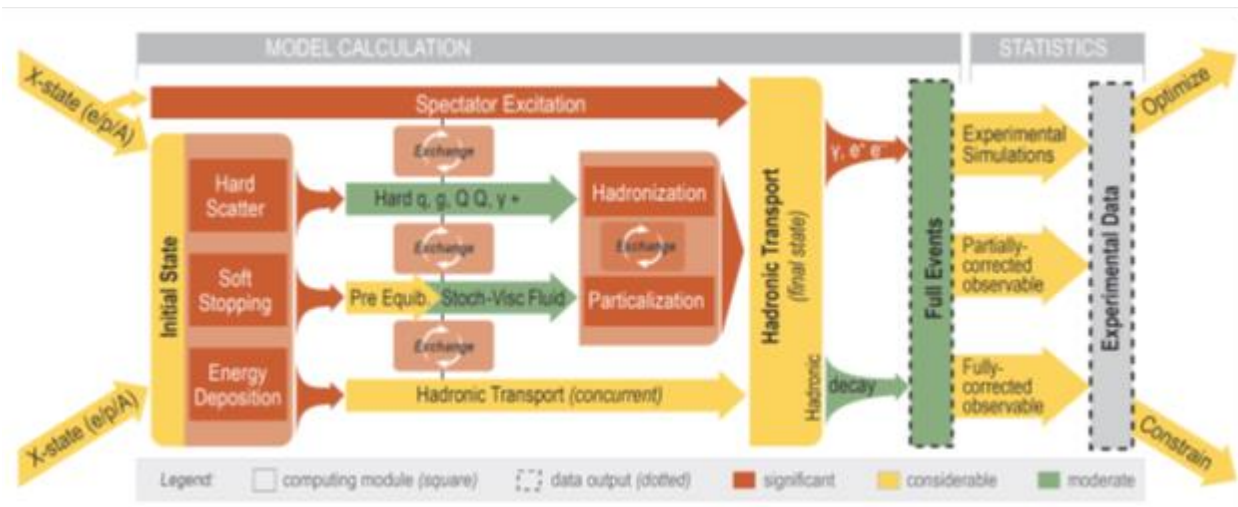

Fig. 1. Schematic Flow Diagram of the X-Scape event generator that will be able to simulate p+p, p+A, A+A, e+p and e+A collisions at high energies.

The first year of X-Scape work has seen major upgrades to the framework. A new clock was implemented that allows the framework to run backwards in time if needed, a feature that will be used to implement initial state radiation. Such an initial state radiation module, as well as a more flexible bulk dynamics manager, to allow for several different ways of computing soft background physics, have been added.

The group at Texas A&M University has continued improvements to hadronization in the JETSCAPE framework, in particular for the Hybrid Hadronization module. This includes a more robust determination of space-time information for hadrons, which is necessary to feed output from hadronization into hadronic transport models, like SMASH. The tuning of Hybrid Hadronization in vacuum was improved by including identified hadron data from both $e^+ + e^-$ and $p + p$ collisions in the pertinent determination of parameters through Bayesian inference. The effects of transverse flow on jets and their hadronization was studied and found to drag soft and intermediate momentum jet hadrons along while high momentum hadrons remain unaffected.

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