Astrophysical collisionless shock waves cover a large variety of physical conditions in terms of magnetizations and velocities. These shock waves convert kinetic or Poynting flux in nonthermal particle energy distribution with variable efficiencies through the interaction with a self-generated multiscale microturbulence. Unveiling the fundamental processes leading to efficient acceleration of high energy charged particles in the various regime of interest is paramount to model the spectra of astrophysical objects such as supernovae remnants (SNRs), gamma-ray bursts, pulsar wind nebulae, active galactic nuclei. More specifically, our work involves numerical studies and analytical models to probe the injection of electrons in subrelativistic shocks of high alfvénic Mach numbers, particularly relevant to SNRs.

To study these highly nonlinear mechanisms that underpin particle acceleration and its backreaction on plasma instabilities, we use the fully kinetic massively parallel Particle-In-Cell (PIC) code Tristan-MP[1]. This approach allows to self-consistently solve the shock dynamics and particle acceleration, albeit at the cost of large-scale simulations. Benefiting from the NIFS and Princeton University computer resources and expertise, we will study the dynamics of high alfvénic MACH numbers in realistic geometries to probe the injection efficiency. These results are important to characterize the correct reduced geometries that probe longer timescales of the shock dynamics.

[1]https://ntoles.github.io/tristan-wiki/