Topological insulators are tunable waveguides for hyperbolic polaritons JHIIH-SHENG WU, DIMITRI BASOV, MICHAEL FOGLER, University of California San Diego — We present a theoretical analysis showing that layered topological insulators, for example, Bi$_2$Se$_3$ are optically hyperbolic materials in a range of THz frequencies. As such, these topological insulators possess deeply sub-diffractional, highly directional collective modes: hyperbolic phonon-polaritons. We predict that in thin crystals the dispersion of these modes is split into discrete sub-bands and is strongly influenced by electron surface states. If the surface states are doped, then hybrid collective modes result from coupling of the phonon-polaritons with surface plasmons. The strength of the hybridization can be controlled by an external gate that varies the chemical potential of the surface states. We also show that momentum-dependence of the plasmon-phonon coupling leads to a polaritonic analog of the Goos-Hänchen effect. Directionality of the polaritonic rays and their tunable Goos-Hänchen shift are observable via THz nanoimaging.