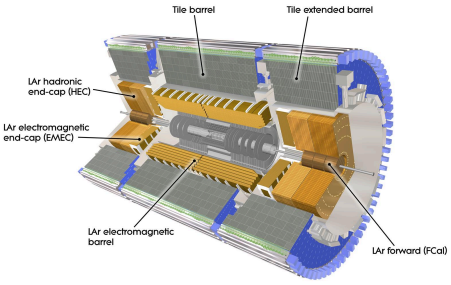
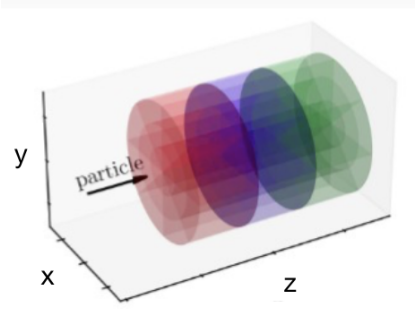
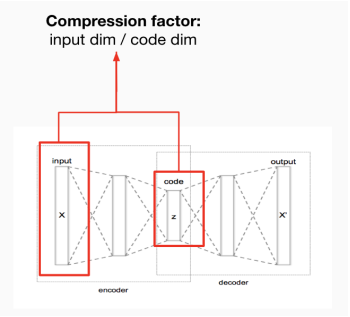
Within particle physics, particle collisions can be experimentally detected and imaged with calorimeters or computationally simulated with current physical models. Comparisons between simulated collisions and experimental results allows researchers to modify current theories of particle physics. A major problem with current simulations (referred to henceforth as “Geant4”) is that they are too computationally expensive. Latent diffusion models trade off computation cost for speed in sample generation, as latent diffusion compresses data into a meaningful latent representation. In past quarters, a latent diffusion pipeline was constructed for speeding up the simulation process, but there were some issues, namely the fact that it was unconditional with respect to energy and also some issues with sampling. Our team completed the latent diffusion pipeline by fixing its issues and getting concrete evaluations to compare with Dr. Amram’s classic diffusion pipeline. Lastly, we generated visual plots and benchmarked loss statistics against the base model. The best model from our pipeline reduced particle shower generation time to under 40%, but also increased FPD to just above 0.4. Future work could include improving model accuracy by tuning hyperparameters to suit the compression and probably changing architecture.



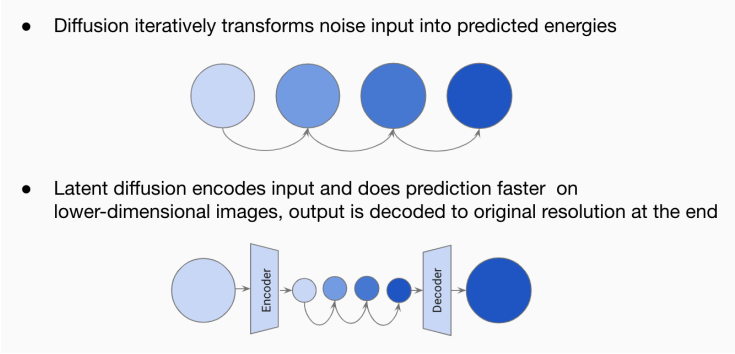
Visualization of Calorimeter



Visualization of Energy Shower



Schematic of Autoencoder



Visualization of Regular and Latent Diffusion Pipeline