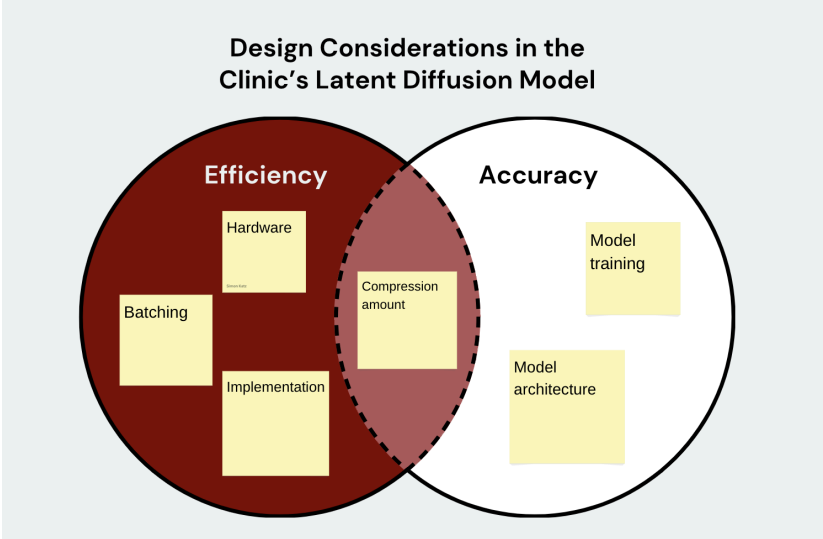
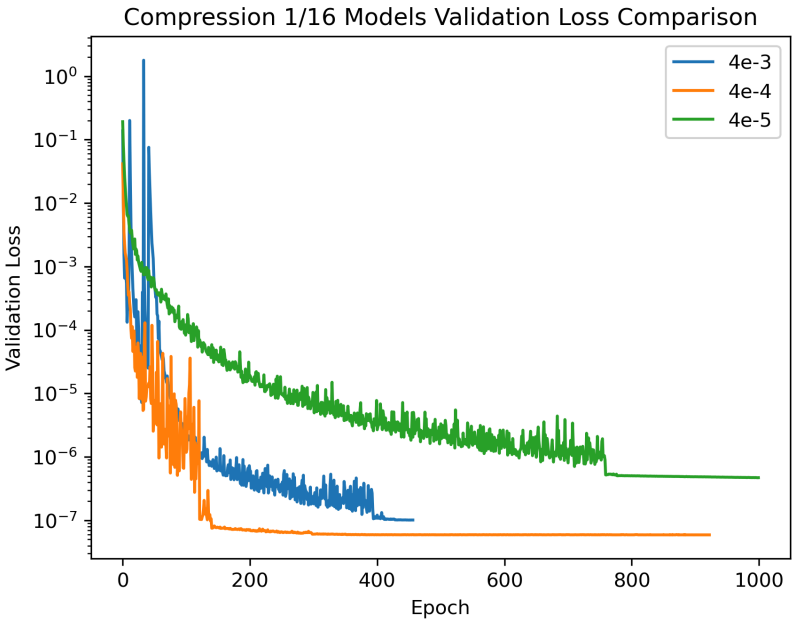
THE UNIVERSITY OF CHICAGO
DATA SCIENCE INSTITUTE

Particle physics research relies on comparing actual particle collisions with computer simulations to test and refine theoretical models. While traditional simulations provide highly accurate results, they are computationally expensive and slow. To address this, researchers at Fermilab developed an AI-based diffusion model which generates particle showers. Building upon this work, the University of Chicago's Data Science Clinic developed a latent diffusion model, which works with compressed data to use less computing power.

The clinic's latent diffusion approach, developed in previous quarters, reduced simulation time to less than 40% of Fermilab's AI-based diffusion model but produced less accurate results than both the traditional simulations and the Fermilab AI-based diffusion model. This quarter, the team focused on improving the latent diffusion model's accuracy while maintaining its efficiency advantage. Through experimenting with different model settings, parameters, and architecture, the team documented how various configurations affected the simulation quality. Depicted below is one experiment comparing learning rates in the auto encoder portion of the latent diffusion pipeline.





The documented relationships between various design choices and their impacts on both accuracy and efficiency create a foundation for further improvements in future quarters.