

# Our Training Strategy

## A Two-Stage Approach

- **Stage 1: Pre-Training**

- **Goal:** Force the model to learn a rich, physical representation of events.
- **How:** A dual-objective Masked Autoencoder (MAE).
  - ▶ *Self-Supervised Reconstruction Task:* Reconstruct masked (hidden) parts of the event.
  - ▶ *Supervised Contrastive Task:* Machine learning framework for grouping hits that share the same voxel ID.

- **Stage 2: Supervised Fine-Tuning**

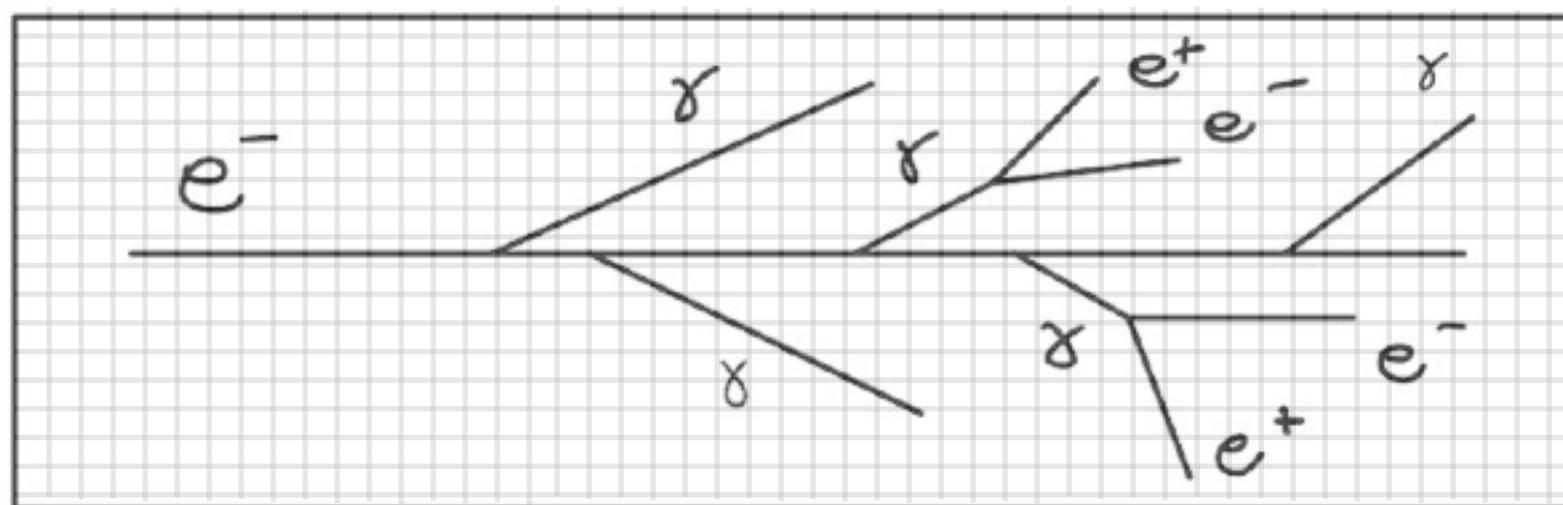
- *Goal:* Adapt the "smart" pre-trained encoder to specific physics tasks.
- *How:* Use the pre-trained weights as a starting point and fine-tune on the labeled dataset for classification and regression.
  - **Classification Task:**
    - *NuE CC, NuMu CC, NuTau CC, NC*
  - **Regression Task:**
    - *Vis Momentum ( $E_{vis}$ ,  $Pt_{miss}$ ), Jet Momentum, Lepton Momentum*

# Pre-Training

## Machine Learning Inputs

- Voxel Energy - Global Event Features - [Voxel ID Labels](#)

Toy Representation EM Shower



- ***hit\_track\_id***: Groups hits from the *same particle* as it propagates.
- ***hit\_primary\_id***: Groups *all hits* that descend from the *same primary particle*.
- ***hit\_pdg***: physics-based grouping, groups hits by PDG code.

