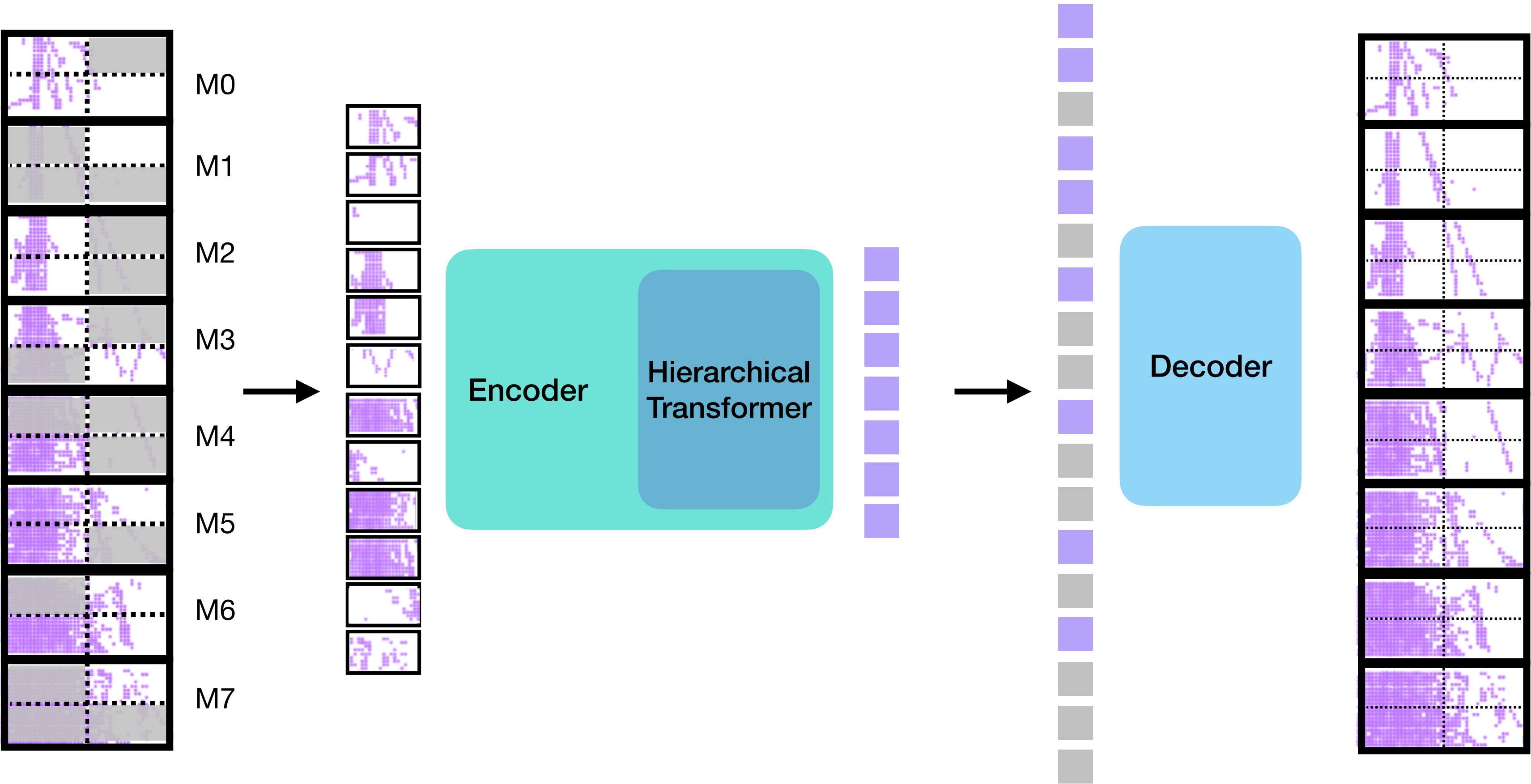
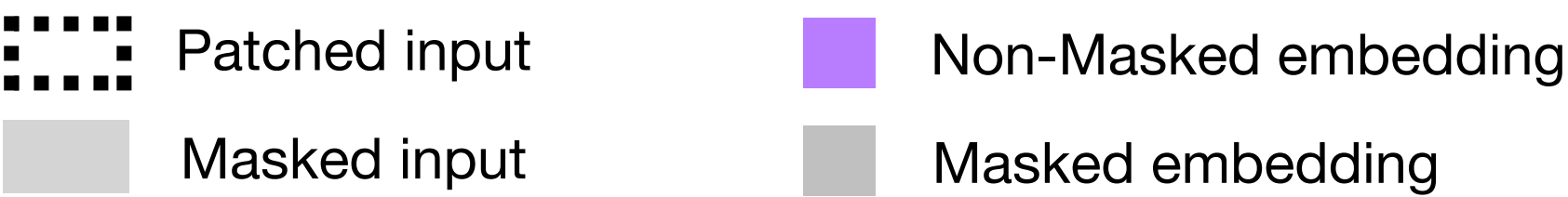


Pre-Training

The Model



Our Training Strategy

A Two-Stage Approach

- Stage 1: Self-Supervised Pre-Training

- *Goal*: Force the model to learn a rich, physical representation of events.
- **How**: A dual-objective Masked Autoencoder (MAE).
 - ▶ *Reconstruction Task*: Reconstruct masked (hidden) parts of the event.
 - ▶ *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**: Transfer Learning - Use the pre-trained weights as a starting point and fine-tune for classification and regression.
 - **Classification Task**:
 - ▶ *NuE CC, NuMu CC, NuTau CC, NC*
 - **Regression Task**:
 - ▶ *Visible Momentum (E_{vis} , Pt_{miss}), Jet Momentum, Lepton Momentum*